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THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

Vol. XVIII January, 1926 No. 1

Chronicle and Comment

Standards Committee Reports

THE Division recommendations to be acted upon at the Standards Committee Meeting on Jan. 26 will be found on p. 17 of this issue of THE JOURNAL.

The Standards Committee Meeting will constitute the last practical opportunity for Society members or non-members to submit evidence in person or in writing to the effect that the recommendations do, or do not, meet the requirements of the industry.

Lack of criticism at, or before, this meeting can only be interpreted as indicating that the reports are in accord with good engineering practice and are satisfactory to the automotive industry.

Discussion of Standards Policy

AT the Standards Committee meeting in Detroit on Jan. 26 the Special Committee on Standardization Policy will make a progress report. In the last year this Committee has been studying important features of standardization work from the standpoint of fundamental considerations as to what practices should be formulated and under what conditions Standards, Recommended Practices or general information should be established and published. It is expected that a number of important points will be commented upon on behalf of the Committee and it is hoped that considerable discussion will be brought out at the meeting on these, or any other, points that members may wish to raise.

Part II 1924 Transactions

AS this issue of THE JOURNAL goes to press, work in preparing the TRANSACTIONS for the last half of 1924 is actively under way both at the printers and in the office of the Publication Department. This volume which, it is expected, will be available about Feb. 15, will consist of approximately 740 pp. and will contain papers presented at the 1924 Semi-Annual, Automotive Transportation and Production Meetings of the Society, others presented at the Section Meetings and contributed articles that were published in THE JOURNAL from July to December, 1924, inclusive, or 30 articles in all. As volumes of the TRANSACTIONS are now sent only to members ordering them and paying the fee of $2 per Part, it will be necessary for members to place their orders by Jan. 20 to be absolutely sure of receiving a copy. For the convenience of the members a TRANSACTIONS order blank will be found in the Advertising Section on p. 96.

Do Not Forget the Carnival

AS a matter of fact, the *Carnival*, the chief social attraction of Annual Meeting week, is perhaps less likely to be forgotten than any single item included in the program. In past years it has proved exceedingly popular, and it is expected that the 1926 event will be no exception. Chairman Walter R. Flannery has enjoyed splendid support from the members of his large Committee who were chosen because of their capability in administering an undertaking of this genre. Elaborate plans for unsurpassed entertainment have been completed and, unless all signs fail, the 1926 Carnival will supply an acceptable means for relaxation and social enjoyment that will not soon be forgotten. See p. 3 for further details.

Annual Meeting Promises Well

DETAILS concerning the 12 technical sessions of the Annual Meeting to be held in Detroit Jan. 26 to 29 have been called to the attention of the members through *Meetings Bulletins* recently issued, and further particulars will be given in a *Meetings Bulletin* that will be mailed about 10 days before the meeting. On p. 5 of this issue of THE JOURNAL will be found a schedule of the sessions, together with brief mention of the ground to be covered by the speakers. In view of the broad scope of the 1926 meeting, there should be very few members who will not find considerable material of interest and value to them. It is hoped that the attendance this year will surpass that in previous years and that the meeting will be recorded as the most successful ever held.

Aeronautics, body-finishes, brakes, engines, fuels, headlighting, lubrication, motorcoaches, production, research, superchargers and vapor-cooling will be the principal topics. The sessions have been so planned as to allow ample time for discussion, for it is believed that a great portion of the benefit from a technical meeting is derived from the active participation of a large number of individuals possessing different points of view and a variety of experiences. It is urged that

those who desire to join in the discussion address the Society headquarters requesting detailed advance information concerning the papers in which they are especially interested.

The Employment Service

THE Society has received in the last year many letters of appreciation of the assistance it has rendered members seeking positions. About 15 per cent of those who requested that bulletins of positions available be sent them were located by the Society. During the year the Service was used by nearly 1000 members. Some of these were employed and seeking better connections. Others who were unemployed found the Service to be a great asset in time of need.

The special attention of chief executives is invited. The membership of the Society is made up principally of high-grade engineers, production managers, service and sales executives and fleet-operation managers. Good men of this type are always in demand and, because of innate reluctance of such men to place themselves openly on the market for positions, it is often very hard to find the right man to fill a particular vacancy. Chief executives can receive considerable assistance in ascertaining the whereabouts of such eligibles through the Society because the system used in the Employment Service is conducted so that the names of men seeking positions and of companies offering positions are kept strictly confidential if desired. The Society serves as a contact-medium for chief executives and members of the Society. Those who wish to do so can conduct their correspondence with each other through the Society by code number.

No charge of any kind is made to either members or companies utilizing this service; and no obligation is incurred in the use of it.

We invite and strongly urge the chief executives of the industry to keep the S.A.E. Employment Service in mind and to take the fullest advantage of it when they are in search of high-grade men.

Dual Pneumatic-Tire Equipment for Motorcoaches

ONE of the most vexing immediate problems, largely of a commercial nature, now before the industry and the motorcoach industry in particular is the matter of center-spacing of dual pneumatic-tire equipment. The Truck Division of the Society's Standards Committee has been studying this problem for some time and recently submitted, in conjunction with the Motorcoach and the Axle and Wheels Divisions, a recommendation that for high-pressure tires center-spacing be provided in the original equipment for the installation upon the vehicles, as later use might prove necessary, of the next size larger tires. Later, at Atlantic City, during the time of the exhibition of the American Electric Railway Association there, an informal conference was held at which the sentiment was expressed that all original equipment should be of tires of such size that later "oversizing" would not be necessary.

At Philadelphia, during the week of the Society's Transportation Meeting there, a third conference, attended by 35 vehicle and tire engineers and others closely identified with the work involved, was held. At this meeting a table of recommended center-spacings and permissible loads for both high-pressure and low-pressure tires, which had been prepared by the Tire & Rim Association, was considered. This table provided for oversizing of original equipment throughout the range of sizes of the two types of tire. The representatives of the tire companies in attendance favored this table. Other engineers participating in the discussion, including those associated with axle companies and particularly motorcoach builders, argued strongly against the oversizing table. The dimensions proposed, together with more detailed information, are given on p. 15 of this issue.

Jordan and Kettering at Annual Dinner

IT would be difficult to imagine a more acceptable combination of speaker and toastmaster for an Annual Dinner than E. S. Jordan and C. F. Kettering, who have consented to favor the Society on the evening of Jan. 14 at the Hotel Astor, New York City. Both of these energetic and interested members of the Society are well known throughout the industry and are sure to assist materially in making the event most pleasurable to all who are fortunate enough to attend.

In conformity with the policy to make the Annual Dinner prominent by its concentration of enjoyment and worth rather than objectionable because of its length and lack of interest, Chairman W. L. Batt and his Committee have considered it advisable to confine the speaking program to Mr. Jordan's address, what Ket. will say, and brief remarks by President Horning and by T. J. Lítle, Jr., nominee for the presidential chair.

A variety of sparkling entertainment and an excellent dinner will be provided, and it is not unreasonable to predict that those who attend the Dinner this year will derive from it a large measure of inspiration. Additional details concerning the Annual Dinner have been printed in *Meetings Bulletins* and will also be found on p. 3 of this issue of THE JOURNAL.

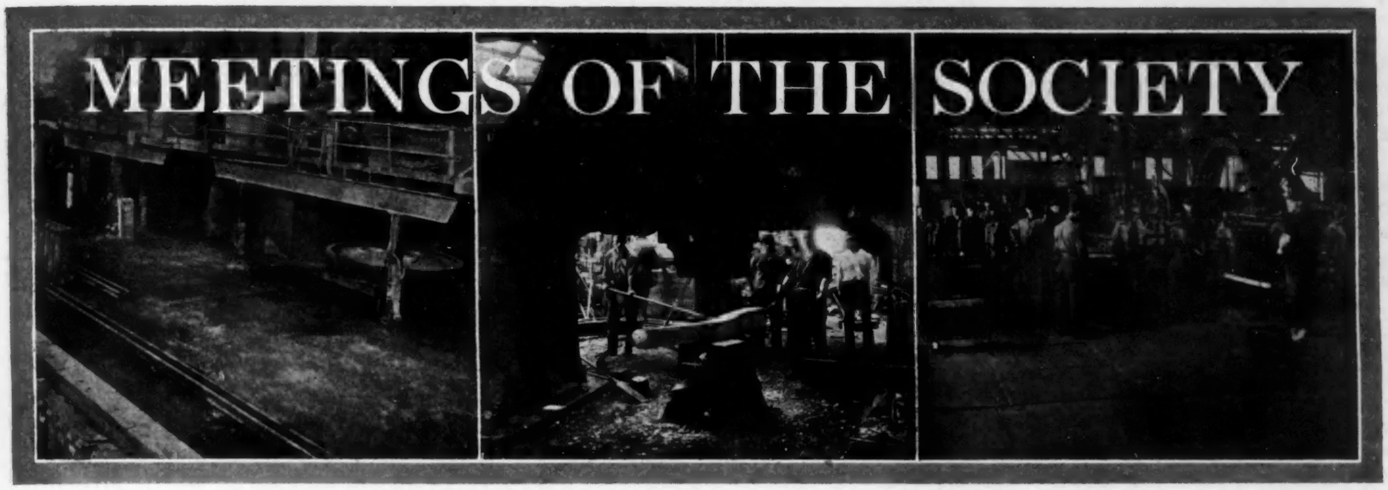
Ohio State Students Active

FOR many months a group of students at Ohio State University have evinced keen interest in Society activities and recently they have taken steps toward the formation of an S.A.E. Students Group. Those who are taking the automotive engineering course have been most prominent in these activities but numerous other students have indicated a desire to see at the University a well-organized unit working to further the interests of the Society and to make its value felt during the undergraduate period.

At the instance of a number of students, headed by William S. Heston, the Council of the Society was petitioned to sanction the formation of a Student Group. This petition was granted at the December meeting of the Council.

Society members will be interested to know that John Younger, C. A. Norman and H. M. Jacklin have consented to act as faculty advisers for the Group and that its officers include: C. W. Smith, chairman; C. H. Croll, vice-chairman; William S. Heston, secretary; and P. R. Wells, treasurer.

Conditions at Ohio State University are such that the Student Group should flourish. The young men constituting its membership are pursuing automotive lines of study by their own choice and have shown commendable initiative in making the necessary arrangements for the establishing of a Group. They will certainly have the best wishes of the Society in their undertaking and can count upon its loyal members for such advice and assistance as may be required by them from time to time.



THE ANNUAL DINNER

C. F. Kettering and Edward S. Jordan To Be Toastmaster and Speaker, Respectively

Past experience has indicated that any Society undertaking that included in its schedule an appearance by C. F. Kettering, of the General Motors Corporation, is at once assured of success. The Annual Dinner at Hotel Astor, New York City, on the evening of Jan. 14 will certainly be classed in this category, for Mr. Kettering has kindly consented to act as toastmaster.

The choice of speakers has also been extremely fortunate, for Edward S. Jordan, president of the Jordan Motor Car Co., will be the only principal speaker and will undoubtedly regale his hearers with an address full of optimism, humor and solid fundamental knowledge. His ability as a speaker and his reputation as a successful participant in progressive business are too well known to require amplification in these columns.

President Horning has agreed to make a few remarks, and it is anticipated that T. J. Lítle, Jr., nominee for the presidential chair, will disclose his plans and desires in a short discourse.

The Dinner will begin promptly at 6:30 p. m., and it is recommended that all those who desire accommodations apply at once to the Headquarters Office on blanks that have been supplied with the *Meetings Bulletins*.

CARNIVAL TO BE BETTER THAN EVER

Popular Social Event of Annual Meeting Week Assured of Success

A prominent member of the Society recently said that the Carnival is one event in the Society's calendar that really needs no advertising. He continued that it is necessary only to provide an event paralleling those that have been produced in past years and to throw open the doors for the multitude to assemble.

This will be done at Oriole Terrace, Detroit, at 9 o'clock, on the evening of Jan. 27, during the Annual Meeting. An announcement of the Carnival, together with an application blank, has been forwarded to every member of the Society, and the returns have thus far been such as to indicate to Walter R. Flannery and his committee that the statement above reported was entirely justified.

THE ANNUAL MEETING APPROACHES

Twelve Technical Sessions Include Items of Predominant Engineering Concern

Referring to the Annual Meeting program printed herewith, it will be noted that this important meeting is scheduled to take place at General Motors Building, Detroit, Jan. 26 to 29. It is believed that the array of interesting topics and the impressive list of speakers will attract a host of engineers to the meeting. A goodly number of more recent problems in automotive engineering, including several whose elements are controversial in their character, will almost certainly stimulate many lively discussions that should result in clearing a number of complicated issues.

In addition to the advantages to be gained from the technical treatment of engineering topics, the possibility for sociability and informal discourse will appeal most strongly to many who rarely if ever have an equal opportunity to enjoy these features.

Supercharger Session

Immediately following registration on the opening day, a session devoted to automobile superchargers will be held. C. R. Short, of the General Motors Corporation, a recognized expert on this problem, will open the session with an extremely interesting study of supercharger developments, both in this Country and abroad, that have extended over a period of years. C. W. Iseler, also of the General Motors Corporation, will follow Mr. Short with a detailed analysis of the important considerations that enter the problem of supercharging present-day automobile engines.

Dr. S. A. Moss, of the General Electric Co., and others well known in this field have consented to present prepared discussion that promises to be one of the most valuable features of the session. The addresses will be illustrated, and various types of supercharger equipment will be exhibited.

Research Session

Since the completion of the new Dodge refrigerated test-chamber, a number of engineers have indicated a desire to know more about the details of construction and use of this equipment. D. M. Pierson, of the Dodge Bros. experimental department, will open the Research Session with a descriptive paper on this topic.

Those who have been associated with the cooperative fuel tests, that have been in progress at the Bureau of Standards for some time, know that a number of very interesting facts have recently developed concerning starting characteristics of fuels and engines. J. O. Eisinger, who has been closely associated with this work, will report interesting and, in some cases, surprising results that have recently been obtained.

Both papers at the Research Session will be profusely illustrated by the use of slides, charts and other adjuncts.

The Standards Committee meeting will convene at the close of the Research Session.

Aeronautic Topics

Grover C. Loening, of the Loening Aeronautical Engineering Corporation, who for many years has been most prominent in the field of aeronautic development, and who in recent years has been markedly successful in the development of amphibian airplanes, will deliver an address on the evening of Tuesday, Jan. 26, that promises to be extremely popular to those who have even a remote interest in current aero-

nautic activity. It will be recalled that the Loening all-metal amphibian was used during the recent MacMillan expedition to the Arctic regions. It has also found extensive application in the tropics and elsewhere.

Mr. Loening's address will be accompanied by a large number of very interesting slides and several reels of motion pictures, many of them of recent origin, showing the all-metal amphibian in use in various climates.

The Annual Business Session will also be held in the evening.

Ralph H. Upson, president of the Aircraft Development Corporation, will open the aeronautic session on Wednesday morning, Jan. 27, with new disclosures concerning metal-clad rigid airship development. Very few persons have as yet had an opportunity to examine the various factors involved in Mr. Upson's development of the metal-clad rigid airship, but the Society is pleased to announce that the hitherto unknown details will be revealed by Mr. Upson's paper. In addition, Mr. Upson has very courteously invited all those who attend the session to inspect the extensive laboratories of the Aircraft Development Corporation, where specimens of material, models and testing equipment will be shown and demonstrated.

H. F. Parker will present a paper on the Economic Spheres of Usefulness of Airship and Airplane which deals with the phases indicated by the title in an unusual manner and with a basis of fact substantiated by recent experience that is very convincing. Mr. Parker's paper will be illustrated.

Brake Session

The Bureau of Standards has conducted, under the supervision of H. H. Allen, an extensive series of practical tests of brake-lining performance under various conditions of temperature. The results of these tests, which should be of great practical value to engineers at this time, will be reported by Mr. Allen at the Wednesday afternoon session.

If you have not experienced trouble from squealing brakes, you are in a unique position. Dr. F. C. Stanley, of the Raybestos Co., will tell why, in his opinion, brakes squeal and will suggest remedies that have been applied very successfully by him in a large number of cases. Dr. Stanley will show simple demonstrations of brake parts to illustrate his findings.

Body-Production Session

Who was it that said that lines and color schemes applied to automobile bodies are in the majority of cases determined by the particular fancy of influential executives? Regardless of whether or not this is the case, certain different effects may definitely be produced by the proper line here or there or by the appropriate allocation of suitable colors. The logical place to look for fundamentally sound information on these topics is in the artistic field, and the Society is indeed fortunate to have obtained a very unusual and valuable paper from H. Ledyard Towle, color adviser to E. I. du Pont de Nemours & Co. Mr. Towle will accompany his presentation with a variety of illustrations, including color panels and other specimens.

What promises to be one of the most interesting and spectacular papers of the entire meeting will be entitled the Nature and Source of the Pigments Used in Automobile Coloring. It will be presented by C. A. Greene, of Valentine & Co. An elaborate series of tests and experiments will be shown by Mr. Greene.

Engine Session

Many inventors and experimenters have for some time been active in their endeavors to produce a heavy-oil engine suitable for use in automobiles and aircraft. One of the most recent and successful of these developments is that of A. C. Attendu, of the Eastern Engineering Co., Ltd. It is understood that the Attendu solid-fuel injection-engine has very successfully undergone a series of exhaustive tests to which it has been subjected by the United States Navy at the Naval Aircraft Factory. The features of this engine and the fundamentals involved in its design and construction will be clearly outlined by Mr. Attendu himself at the morning session on Thursday, Jan. 28. It is hoped that Mr. Attendu may have an engine on exhibition at the session.

Will a properly lubricated engine ever wear out? T. E. Coleman, of the Madison-Kipp Corporation, and J. B. Fisher, of the Waukesha Motor Co., in a paper entitled the Mechanical Elements of Engine Lubrication, will report results that they have obtained in practical tests covering the direct lubrication of the working parts in engines. It is understood that these tests have brought out a number of very interesting facts and characteristics.

The Headlighting Symposium

It would be difficult indeed to select a topic that is at present more perplexing or of greater interest than automobile headlighting. A combination technical session and symposium scheduled for Thursday afternoon will provide ample opportunity for all angles of this problem to be thoroughly discussed. L. C. Porter of the Edison Lamp Works of the General Electric Co., and Walter D'Arcy Ryan, of the General Electric Co., have prepared two very practical papers. The first has especial reference to the mechanical and optical factors that are so intimately associated in creating the present situation. What is the effect of improper bulb position and how are road illumination and glare affected by the many items that enter the construction, design and application of present-day headlighting equipment? Mr. Porter will illustrate his findings on the above topics with an ingenious arrangement of apparatus simulating conditions that prevail on the highways.

Mr. Ryan and several of his staff have for a number of months been engaged in a series of technical experiments and tests with headlighting equipment now in use and will tell whether or not these tests indicate that satisfactory road illumination at a distance can be obtained without glare and discomfort to the approaching driver.

A number of experts, representing the various angles of the headlighting problem, will participate in the symposium that has been designed to consolidate in a single session the more important phases upon which a satisfactory solution will depend. This symposium will undoubtedly bring to light in logical sequence many fundamental factors and proposals of real importance.

The Motorcoach Session

Frank R. Fageol, of the Fageol Motors Co., who is perhaps one of the most interesting figures in the progressive field of motorcoach development, will present on Thursday evening a paper covering the problems with which he has been confronted in the development of the motorcoach body and chassis. He will discuss in detail his methods of answering many difficult questions that have arisen and will give his reasons for the decisions that have been reached.

A. F. Masury and L. C. Josephs, Jr., of the International Motor Co., will discuss the heating and ventilating of motorcoach bodies.

The Vapor Cooling Session

The number of opinions on the principles of vapor cooling is certainly greater than the systems for applying this method. On Friday morning, Jan. 29, a paper by S. W. Rushmore and A. G. Herreshoff will reveal in detail the attitude of the Rushmore Laboratory and will present the technical basis for this attitude.

Alex. Taub, of the Chevrolet Motor Co., and L. P. Saunders, of the Harrison Radiator Corporation, will present their views on this topic that has reached a stage of great importance in the automotive industry.

Fuels and Lubrication Session

Are compression pressures going up and, if so, what type of fuel will be required for satisfactory service in the newer engines? Is the petroleum industry in a position to supply these fuels as soon as the demand becomes apparent and are automotive manufacturers inclined toward changes in engine design? Dr. T. G. Delbridge and Dr. J. B. Hill, of the Atlantic Refining Co., will give a paper on Friday afternoon,

ANNUAL MEETING PROGRAM

General Motors Building Jan. 26 to 29 Detroit

Tuesday, Jan. 26

9:00 a. m.—REGISTRATION

10:00 a. m.—AUTOMOBILE SUPERCHARGER SESSION

Supercharging Internal-Combustion Engines—C. R. Short, General Motors Corporation

Practical Application of Superchargers to Automobile Engines—C. W. Iseler, General Motors Corporation

Dr. S. A. Moss, General Electric Co., and other authorities will present prepared discussion. The addresses will be illustrated and various types of supercharger equipment will be exhibited

12:30 p. m.—LUNCHEON

1:30 p. m.—RESEARCH SESSION

An Improved Type of Refrigerated Test Chamber—D. M. Pierson, Dodge Bros., Inc.

Engine Starting Tests—J. O. Eisinger, Bureau of Standards

Both papers will be profusely illustrated

3:30 p. m.—STANDARDS COMMITTEE MEETING

This meeting will convene at the close of the Research Session

7:30 p. m.—ADDRESS ON THE DEVELOPMENT OF AMPHIBIAN AIRPLANES—Grover C. Loening, Loening Aeronautical Engineering Corporation

Mr. Loening's address will be illustrated with slides and motion pictures showing amphibian airplanes in use in many climates. Ladies are cordially invited to attend

The Annual Business Meeting will also be held in the evening

Wednesday, Jan. 27

9:30 a. m.—AERONAUTIC SESSION

Metalclad Rigid Airship Development—Ralph H. Upson, Aircraft Development Corporation

The Economic Spheres of Usefulness of Airship and Airplane—H. F. Parker

Both papers will be illustrated

Following the session Mr. Upson will be the host of members who wish to inspect the extensive laboratories of the Aircraft Development Corporation. Specimens of material, models and testing equipment will be shown and demonstrated

1:00 p. m.—LUNCHEON

2:30 p. m.—BRAKE SESSION

The Effect of Change of Temperature of Brake-Linings on Their Performance—H. H. Allen, Bureau of Standards

Causes and Cures for Brake Squealing—Dr. F. C. Stanley, Raybestos Co.

Both papers will be illustrated

Simple demonstrations on brake parts will be shown

2:30 p. m.—BODY PRODUCTION SESSION

Color Harmony in the Automotive Industry—"The Pot of Gold at the End of the Rainbow"—H. Ledyard Towle, E. I. du Pont de Nemours & Co.

The Nature and Source of the Pigments used in Automobile Coloring—C. A. Greene, Valentine & Co.

Mr. Towle's paper will be graphically illustrated by samples, drawings and slides

Mr. Greene will offer an elaborate series of tests and experiments

9:00 p. m.—THE CARNIVAL AT ORIOLE TERRACE

Thursday, Jan. 28

10:30 a. m.—ENGINE SESSION

The Attendu Heavy Oil Engine—A. C. Attendu, Eastern Engineering Co., Ltd.

Mechanical Elements of Engine Lubrication — T. E. Coleman, Madison-Kipp Corporation, and J. B. Fisher, Waukesha Motor Co.

Interesting exhibits will be shown

1:00 p. m.—LUNCHEON

2:00 p. m.—HEADLIGHTING SYMPOSIUM

Papers by L. C. Porter and W. D'A. Ryan, General Electric Co.

Prominent representatives of manufacturing, servicing, scientific, administrative and research organizations will take part in the symposium

Elaborate demonstrations will be made

7:30 p. m.—MOTORCOACH SESSION

Problems in the Development of the Motorcoach Body and Chassis—Frank Fageol, Fageol Motors Co.

The Heating and Ventilating of Motorcoach Bodies—A. F. Masury and L. C. Josephs, Jr., International Motor Co.

Friday, Jan. 29

9:30 a. m.—VAPOR COOLING SESSION

Vapor Cooling Developments—S. W. Rushmore and A. G. Herreshoff, Rushmore Laboratory; Alex Taub, Chevrolet Motor Co., and L. P. Saunders, Harrison Radiator Corporation

1:00 p. m.—LUNCHEON

2:00 p. m.—FUELS AND LUBRICATION SESSION

Engine Requirements and the New Fuels—Dr. T. G. Delbridge and Dr. J. B. Hill, Atlantic Refining Co.

Gasoline and New Fuel Tests—W. S. James, Associated Oil Co.

A Suggested Remedy for Crankcase Dilution—R. E. Wilson, Standard Oil Co. of Indiana

All papers will be illustrated

Mr. James will give an interesting demonstration

2:00 p. m.—PRODUCTION SESSION

The Application of Group Bonus to Non-Productive Labor — Joseph Lannen, Paige-Detroit Motor Car Co.

The Production of All-Steel Bodies Shown by Motion Pictures—J. Ledwinka, E. G. Budd Mfg. Co.

treating a number of interesting phases of this question that looks into the future.

At the same session, W. S. James, of the Associated Oil Co., will explain and demonstrate new fuel tests and will devote considerable attention to the topic of gasoline in general.

Robert E. Wilson, of the Standard Oil Co. of Indiana, will suggest a remedy for crankcase-oil dilution that will doubtless be the subject of considerable discussion.

It can be safely predicted that this session will produce a number of sensations and that the discussion will be at once lively and worth-while.

The Production Session

Wage Incentives for the Machine-Tool Repair and Maintenance Department will be the topic under discussion by Joseph Lannen, of the Paige-Detroit Motor Car Co., at the Production Session, also scheduled for Friday afternoon.

The Production of All-Steel Bodies will be discussed in detail by J. Ledwinka, of the E. G. Budd Mfg. Co., who will show a number of motion-picture films and slides illustrating the processes included in his paper.

EXHIBITS AND DEMONSTRATIONS

Annual Meeting Sessions To Be Notable for Displays and Graphic Presentations

It is doubtful whether the Society has ever before held a national meeting at which so many displays of equipment, demonstrations of apparatus and graphic illustrations of technical matters have been utilized as will be the case at the Annual Meeting in Detroit, Jan. 26 to 29. It is the firm conviction of the Meetings Committee that adjuncts of this nature that appeal to the optical sense assist very materially in making the technical papers more easily understood and capable of producing indelible impressions upon the memory.

RACING ENGINES AND SUPERCHARGERS

Indiana Section Hears How Latter Affect Airplanes and Racing Aids Engine Design

How speedway racing has brought about the development of high-powered small engines fitted with superchargers was reviewed by August Duesenberg, and the effects of superchargers on airplane engines at different altitudes were explained by Lieut. C. H. Ridenour, of McCook Field, at a meeting of the Indiana Section at the Hotel Severin, Indianapolis, on the evening of Dec. 10.

Fifty-one members sat down to the dinner that preceded the technical meeting, at which 150 were present. George T. Briggs presided as chairman and the meeting elected William G. Wall, Howard C. Marmon, Fred E. Moskovics, George T. Briggs and Fred S. Duesenberg to serve as a committee to nominate Section officers for next year. Mr. Briggs was unanimously elected a member of the Sections Committee of the Society to represent the Indiana Section for 1926.

Although the meeting felt disappointment over the fact that Fred S. Duesenberg, who was to present his paper on high-duty automobile engines, was detained by business in California, his brother August delivered the address and explained the three lantern-slide charts that accompanied it most acceptably. The meeting regarded Lieutenant Ridenour's technical description, illustrated with eight charts, of a series of airplane tests to determine the effects of superchargers on engine performance at different altitudes as such an important contribution to the automotive industry that it gave him a rising vote of thanks and asked the Secretary to write to Major Curry, commanding officer of McCook Field, thanking him for granting permission for the preparation and delivery of the paper. Both papers elicited many questions and much discussion by the keenly interested hearers.

How Racing Has Improved Engines

Mr. Duesenberg showed how the rule limiting cubic-inch piston-displacement in entries for speedway races at Indianapolis had resulted in reducing the size of engines from 600-cu. in. displacement in 1911 and 1912 to the present racing engine of 122-cu. in. displacement and the coming engine of 91-cu. in. displacement. With these reductions in size, the average speed of the cars in the 500-mile races has increased from about 75 m.p.h. in 1911 to 127 m.p.h. in 1925, and the number of cylinders from four to eight. Everything indicates, said Mr. Duesenberg, that the present racing cars with 122-cu. in. displacement engines, if properly streamlined and with proper gear-ratio, would equal the Beach record of 156.5 m.p.h. made with a car fitted with two 300-cu. in.-displacement engines. Superchargers were fitted to the cars in 1924 and last April Peter DePaolo made a speed of 139.7 m.p.h. for one lap of the Culver City speedway on the Pacific Coast, and this winter Earl Cooper turned a lap there at a speed of 141.6 m.p.h. In these trials the engines have attained a speed of 5500 r.p.m. It is safe to say that the 91-cu. in. engines will equal the speed of the present 122-cu. in. engines within the 3 years during which the new rule will prevail, said Mr. Duesenberg. When it is realized that these cars are driven by engines that are just half the size of the Ford engine, it is evident that great advancement has been made in high-duty engines as a result of racing.

Superchargers Good at Right Heights

Airplane engines fitted with superchargers deliver less power at sea level and at altitudes above the altitude rating of the supercharger, due to the power required to drive the supercharger, heating of the air in the supercharger, variation in mean effective pressure, and variation in propeller characteristics with atmospheric density and speed of the propeller, said Lieutenant Ridenour. It appears probable that the most desirable supercharger will be one having an intermediate altitude rating that will not penalize the engine too severely at low altitudes but will give a substantial increase in performance at greater altitudes. The Engineering Division at McCook Field has experimented with gear-driven superchargers of 20,000-ft. altitude rating, fitted with an air-cooler and having the carbureter on the pressure side, and with the gear-driven type rated at 7500-ft. altitude, without an air-cooler and having the carbureter on the suction side. The charts showed increases of horsepower output by supercharged engines with increases of altitude from sea level to the altitudes for which the superchargers were rated, followed by rapid decreases of power as still greater altitudes were attained.

EVAPORATIVE-COOLING SYSTEMS

Use of the Evaporation and Condensation of Steam Interests Detroit Section

Taking exception to the description of an evaporative-cooling system as being "steam-cooled," because of the resistance encountered on account of association of this term with steam heating, H. C. Harrison, president of the Harrison Radiator Corporation, Lockport, N. Y., entertained the members of the Detroit Section and their guests, at the regular semi-monthly meeting of the Section on Dec. 3, with his experiences in the last 7 years and the conclusions he had reached with regard to this method of cooling.

Although it is true, he said, that water is caused to boil and steam to be formed in the cylinder-jackets of an engine using the evaporative-cooling system, the steam so formed is a very small part by weight of the cooling fluid and, having a low specific-heat, has practically nothing to do with the cooling of the cylinder-block. The radiator, or condenser, moreover, in which the steam is condensed is of the ordinary air-cooled type. The cooling is produced by the evaporation of water

SCHEDULE OF SECTIONS MEETINGS

JANUARY

8—SOUTHERN CALIFORNIA SECTION—How to Determine Correct Carbureter Adjustment and Effects of Improper Adjustment on Economy, Power, Carbon, Engine Wear, and Crankcase Dilution—J. F. Dixon and O. H. Ensign
8—WASHINGTON SECTION—Motor-Vehicle Headlighting—R. E. Carlson
11—METROPOLITAN SECTION—What's New at the Show?—Short discussion by engineers from each of the companies exhibiting cars at the New York City Automobile Show
19—BUFFALO SECTION—Opportunity in Transportation for the Automotive Engineer—J. E. Schipper
20—DAYTON SECTION—Aerial Photography—Lieut. George Goddard

into steam in the cylinder-jacket and by the conveying of the steam to an air condenser where its latent heat is given up.

In spite of its well-known shortcomings, the water-cooling system has held the field for the last 25 years, Mr. Harrison continued. But however designed it cannot be made suitable for widely varying conditions of climate and of driving. Besides the danger of both overheating and overcooling, apart from freezing, quantities of heat are rejected that bear little relation to the requirements. Radiators that are made large enough to provide for the most severe demands of operation with wide-open throttle at maximum speed in a hot climate are unsuitable for normal operation in cold weather at part throttle.

The original problem was to meet all practical conditions so that an engine could be cooled by allowing the water to boil in the cylinder-jackets, the steam formed to be condensed, and the condensate returned. Although sounding simple this problem involved a consideration of many combinations of pressure, temperature and direction of flow.

ADVANTAGES OF EVAPORATIVE COOLING

Careful investigation of variations that produced the maximum benefit led to the following definite conclusions as to the advantages of an evaporative cooling system:

(1) A constant-temperature fluid is provided as the cooling agent surrounding the cylinder-block, irrespective of the climatic conditions or the power developed, the temperature being determined solely by the pressure of the cooling fluid
(2) As the temperature of the cooling fluid is substantially 212 deg. fahr., crankcase-oil dilution is practically eliminated
(3) If the system is properly arranged, volatile anti-freeze solutions can be added without loss
(4) Even if no anti-freeze mixture is present, the condensing radiator, even if frozen, will be self-thawing in operation
(5) Under part throttle, great economy of operation can be expected in cold weather
(6) Due to the more constant conditions of lubrication, economy of oil can be expected in any case
(7) Carbureter settings can be made for a hot engine, cold weather driving being ignored

OPERATION OF THE SYSTEM

An evaporative cooling-system will not eliminate heat, unless heat should be rejected from the system, but will adjust its amount to the needs of heat rejection. One standard cooling-system will provide the best kind of driving in winter or summer, in Alaska or in Florida.

Mr. Harrison explained that, although the general idea was not new, the particular solution that was investigated was new and consisted of a double circuit, one part being for the circulation of the boiling water, and one for the circulation of the steam through the radiator-condenser and the return of the condensate to the engine block. Although satisfactory in operation the use of two pumps met with considerable opposition. Researches showed that, if the use of only one pump were contemplated, it was preferable to circulate wet steam and to cause the separation of the steam and water in some part of the system other than the cylinder-head of the engine; the use of both sub and superatmospheric-pressure systems was also abandoned.

After experimenting with up-flow, down-flow and cross-flow radiators, the last-named was found to be an ideal exemplification of the original effort. By introducing wet steam at one side of the radiator core and allowing the water to traverse the lower tubes and the steam the upper ones, the steam is condensed and trickles down to the water, which collects at the bottom, and both can be returned by one pump to the cylinder-block. This method differs from that of the original installation only in that the circuits are all contained within the radiator instead of in pipes external to it.

USE OF CENTRIFUGAL PUMP

Inasmuch as an ordinary centrifugal pump will not operate unless the level of the pump is such that it will be self-priming and can free itself automatically from air by venting back to the cold side, a variation is made by allowing the water level to rise to a point at which the pump becomes self-priming. The radiator will then be half-filled with water and only one-half of the core will be utilized as a condenser. To prevent such an arrangement from running too cool under part throttle, a baffle-plate is inserted in the pump-suction line. When boiling occurs in the cylinder-jacket, the distension of the liquid causes the water to overflow the baffle-plate, augmenting the quantity of water available for the pump to throw, immediately increasing the circulation and reducing the temperature of the liquid and consequently its level to a point at which the additional circulation is caused to stop. This arrangement is applicable to cars in which the pump is located at an artificially high level.

Inasmuch as the problem is merely to cool an internal-combustion engine with boiling water, using the water as a carrier of the steam produced and transferring the heat contained in the steam to a system suitable for condensing the steam and wasting its latent heat by condensation, the general principles said to apply are as follows:

GENERAL PRINCIPLES OF EVAPORATIVE COOLING

(1) Water, being a non-conductor and serving mainly to carry the steam, which is the heat container, should be circulated rapidly through the jackets and into the cooling-system
(2) The cooling-system, or condenser, should be arranged to allow the maximum mean temperature-difference between the air and the core
(3) The water itself need not be cooled, but a centrifugal pump will operate better if the water is cooled slightly, and experience has shown that a gear pump is desirable
(4) The system should be arranged so that there will be no chance of an air-lock in the condenser, and the cold side of the condenser should be vented to the atmosphere
(5) Provision should be made to take care of residual

heat in the engine block, to avoid or minimize loss of steam or water after hard driving and sudden stopping

(6) The system should under no circumstances be capable of loss of water or alcohol under the hardest continuous driving for indefinite periods

(7) The efficiency of the condenser will depend largely on the rate of circulation of the steam through the condenser, and nothing should be allowed to retard the circulation

(8) The air-flow and rise of temperature of the air are interdependent, depending on the quantity of air passed and on the turbulence within the radiator; but the total resistance of the system, including the hood, to air-flow must be considered

(9) The system should be capable of being installed upon a standard car with no alterations, merely replacing the standard radiator with a condensing one

(10) The system, if completely filled with water, should be capable of running as a superior water-cooled system

URBAN TRANSPORTATION SERVICE

Coordinated Motorcoach and Street-Car Service Outlined to Buffalo Section

Electric-railway transportation-service history and details of coordinated motorcoach and street-car service in the city of Albany, N. Y., and its environs were the topics presented by Ernest A. Murphy, general manager of the United Traction Co. of that city, to the members and guests of the Buffalo Section at the meeting held on Dec. 15. During the lengthy discussion following the presentation of the paper, many additional factors of motorcoach operation were considered. Mr. Murphy said in part:

> The trolley lines of the Capitol District of New York State operate at a cost of between 53 and 55 cents per car-mile, including all fixed charges. The 29-passenger motorcoach in the same territory operates at a cost of between 27 and 29 cents per vehicle-mile, including all fixed charges. As the motorcoach has only one-half the carrying capacity of the trolley car, we are faced with a greater cost for handling passengers in the rush hour with motorcoaches than with trolley cars. In comparison with the cost of operation of the trolley line, it is obvious that other factors must be considered if the motorcoach is adopted for mass transportation. Stating the actual cost where abandonment of certain track structures is being made and motorcoaches substituted, a complete trolley line operated 46,347 car-miles at 54 cents per car-mile during 1 month; the total expenses were \$24,977.38 and the total revenue was \$18,927.83, which constituted an operating loss of \$6,049.55 for 1 month.
>
> The following year, part of the trolley line was abandoned and motorcoaches were substituted at the same rate of fare with an increase in motorcoach mileage. The remaining portion of the trolley line operated 34,617 car-miles at 51 cents per car-mile; the total expenses were \$18,065.69 and the total revenue was \$15,316.21, which constituted an operating loss of \$2,749.48 for 1 month. In the same month, the motorcoaches operated 31,803 motorcoach-miles at 27.3 cents per vehicle-mile; the total expenses were \$8,682.22 and the total revenue was \$8,208.04, which constituted an operating loss of \$474.18 for 1 month. This motorcoach loss, added to the car-line loss gives a total loss for both systems of \$3,323.66 for combined operation, as compared with the car-line operating-loss of \$6,049.55 for the same month of the previous year.

Continuing, Mr. Murphy stated that numerous trolley routes exist in the complete trolley system of some cities on which the earnings per mile will never reach the operating cost per mile. Hence, the particular phase of electric railways that the motorcoach sales-engineer should study is indicated. He should place himself in a position to advise with the railway engineer as to what the estimated cost for motorcoach operation will be over the route of the line proposed for abandonment and also regarding the standard type of equipment to be adopted.

Concerning the gasoline-electric motorcoach, Mr. Murphy said that it has proved itself by limiting operation abuses by careless drivers and by providing rapid acceleration and smooth performance. He believes that the building of the gasoline-electric unit does not mean simply removing the mechanical transmission from a standard unit and requiring the electric companies to furnish generators and motors to fit the chassis. In his opinion, the machine to be turned out in the future will be a unit completely designed by the motorcoach builder, in cooperation with the electric companies, thereby coordinating engineering resources to provide the maximum power development that the combined engine and generator can deliver to the driving motors.

AIR-CLEANER APPLICATION DISCUSSED

Milwaukee Section Hears Paper by H. L. Mills and Debate Subject at Length

Principles on which the several types of air-cleaner operate and the advantages and disadvantages of each type as applied to automotive vehicles were reviewed in an informative and timely paper delivered by H. L. Mills, vice-president and general manager of the United Mfg. & Distributing Co., at the Dec. 2 meeting of the Milwaukee Section. The meeting was attended by 34 members, many of whom took part in the discussion, which brought out much practical information regarding the action and effect of the dry inertia-type air-cleaner. Models of this type produced for application to Locomobile, Lincoln and Chrysler cars were shown and demonstrated by the speaker.

Nominating Committee Elected

Prior to delivery of the address, the Section elected a committee consisting of A. D. Chandler, W. A. Starck, Leon J. D. Healy, John J. Balsom, and A. F. Milbrath to prepare nominations for officers of the Section, and reelected Fred M. Young, of the Racine Radiator Co., to succeed himself as representative of the Section on the Sections Committee of the Society.

In the absence of J. B. Armitage, chairman of the Section, in New Mexico, on account of illness, Vice-Chairman George W. Smith presided over the meeting.

Objections to Some Types of Air-Cleaner

Mr. Mills discussed in his paper each of the three types of air-cleaner, the liquid, the filter and the dry inertia, the last of which is now presented to the trade in three classes. He pointed out objections to the first two types in their practical application to automobiles, such as failure of a small body of water to remove the dust from a large volume of air that passes through it in large bubbles, evaporation and freezing of the water, variation in carbureter restriction as the volume of water varies, reduction of temperature of the intake air by passing through the water, thickening of a body of liquid oil at low temperature with consequent restriction of the passage of air, clogging the pores of oil-filter air-cleaners by accumulated dust and by swelling of the fibers of the cloth due to humidity resulting in restriction; and the need of frequent cleaning or renewal of the filter.

Inertia-type cleaners that accomplish separation of the dust by change of direction of the air current at high velocity have the disadvantage, he said, when applied to automobiles, that the air velocity through the device is proportional to the engine speed instead of to the volume of air the engine is using; hence, with a wide-open throttle and the engine laboring, or with the fan-belt slipping, the efficiency of the cleaner is reduced. Moreover, if the air-cleaner is mounted directly back of the radiator and facing forward, the maximum of dust is carried into it with the air.

Efficiency of the centrifugal type is dependent upon the velocity of the air as it enters and leaves the device, the air in the cleaner at no time moving faster than the velocity as it enters and the centrifugal force being limited to the initial velocity available. Cleaners of this class that are fitted with receptacles for holding the separated material lose some or all of their efficiency, he said, if air leaks around the box or if the box is not in place. Furthermore, all of the air that enters the cleaner passes into the engine and carries with it any dirt that is not separated out.

Requirements of an Ideal Air-Cleaner

An inertia air-cleaner that embodies both the principle of quick change of direction of the air current and that of centrifugal force and has a rotor actuated by the current of air passing through the cleaner and a rate of rotation that is proportional to the amount and velocity of air passing through it, subjects the air to a greater centrifugal force and has a high cleaning efficiency, rejects the portion of the air that contains the dust, is self-cleaning and requires no attention whatever. It takes in more air at the top than is passed to the engine, and the rotor, driven by a turbine below it, has a supercharging effect under certain conditions that increases the efficiency of the engine at the lower speeds.

Requirements that the ideal air-cleaner must meet were summarized by the speaker as (*a*) small size, (*b*) lightness, (*c*) low price, (*d*) high cleaning-efficiency, (*e*) minimum restriction, (*f*) non-variation of restriction, and (*g*) independence of attention from operator for continued operation at maximum efficiency.

Auxiliary Inlet for High Speed

In his demonstration and replies to questions, Mr. Mills explained that the Locomobile model inertia-type air-cleaner has an auxiliary valve that opens when the engine speed goes up to about 3000 r.p.m. to avoid increase of restriction. A twin installation is used on tractors, one cleaner operating at low engine-speeds and the other coming into action at higher speeds. This avoids the use of a very large cleaner, which would not be actuated by the small volume of air that would pass through it at low speed.

Disastrous effects from backfiring are avoided by providing a short pin and a louver in the top of the air-cleaner to relieve the pressure.

The explanation offered for the increase in horsepower output is that the turbine of the cleaner overcomes to an extent the surging of the air due to alternating suction of the cylinders and sudden closing of the inlet-valves, causing a rebounding of the air.

Provision of the auxiliary air-valve on the Lincoln car enables the engine to go to 2800 r.p.m. at full load without any horsepower loss. When additional air is admitted, however, the cleaning efficiency of the device is lessened somewhat. All air-cleaners are a compromise, said Mr. Mills, between what it is desired to accomplish and the requirements of practical application to the engine.

INFLUENCE OF DETONATION ON DESIGN

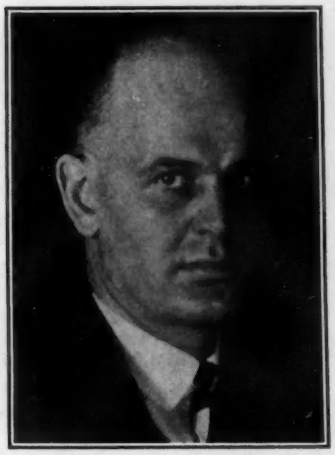
Southern California Section Studies Desirable Motor-Fuel Characteristics

Detonation causes and effects, how detonation is produced and prevented, and what it has done, is doing and will do generally to influence motor-vehicle design, construction and operation were the subjects discussed at the meeting of the Southern California Section held on Dec. 11 at the City Club in Los Angeles. R. E. Haylett, manager of research and development for the Union Oil Co. of California, presented the paper, giving first a brief outline of the manufacture of gasoline and its preparation for automotive consumption. He described also the causes of detonation and its effects, the use of chemicals for the prevention of detonation and the relative merit of the specific-gravity standard as a test of gasoline value, emphasizing the necessity of providing a proper explosive mixture for an engine in order that economical operation can be attained.

Eugene Power, superintendent of automotive equipment for the Union Oil Co. of California, was elected at this meeting to represent the Southern California Section on the 1926 Sections Committee of the Society. The regular nominating committee was also elected, its members being: W. H. Fairbanks, R. S. Crocker, J. J. Murray, C. H. Jacobsen, and E. J. Annis.

STEAM-COOLING ELUCIDATED

Herreshoff Demonstrates and Explains Major Advantages to Washington Section


A. G. Herreshoff

Maintaining a uniform temperature of 212 deg. fahr. in the cylinder-jacket of an internal-combustion engine not only increases the efficiency under part load but greatly prolongs the useful life of the engine by maintaining the lubricating value of the oil and preventing rust, members of the Washington Section were told by A. G. Herreshoff, of the Rushmore Laboratory, at a meeting held on the evening of Dec. 11 at the Cosmos Club, City of Washington.

The effect of variation of temperature on the formation of rust was demonstrated with simple apparatus and a number of lantern slides were shown of Ford and Buick cars fitted with steam-cooling systems, of a schematic drawing of a radiator designed for steam-cooling and of a steam-heater applied to a Buick sedan. The speaker also exhibited a small model in which an electric immersion heater was enclosed in a glass water-jacket to illustrate the action that occurs in the water-jacket of an engine when the engine warms-up.

Some of the points made by the speaker were that, when an engine is stopped with cold jackets, the cylinder-walls become coated with rust, whereas, when stopped with hot jackets, no rust forms; steam-cooled engines produce as much maximum brake horsepower as water-cooled engines, are not prone to preignition or detonation, and the phenomenon of steam bubbles adhering to the cylinder-walls does not occur; a reduction of from 50 to 70 per cent in piston friction is effected by raising the jacket temperature from 122 to 212 deg., and a fuel saving of from 15 to 20 per cent is obtained in road-tests; longer useful life of the engine results from elimination of crankcase-oil dilution while running and by quicker heating and slower cooling of the engine; anti-freeze solutions put into the water of a steam-cooled car remain indefinitely; with an abundance of steam, the heating of closed cars is a simple matter, and by steam-heating the oil-pan, uniform and relatively low viscosity of the oil is maintained.

The Engine of the Future

Visualizing the engine of the future as steam-cooled, Mr. Herreshoff said:

> It will have its reserve water carried in an oil-pan jacket, with the water-pump at the level of the bottom of such jacket. It will have the steam pipe from the cylinder-head to the bottom of the radiator, as well as the water-supply pipe, cast in the engine block so that no cooling pipes will be visible, and will be made with a smooth exterior so that it can be jacketed completely with cork or felt. Such an engine would retain its heat over night in cold weather as practically no heat loss would occur after the formation of steam had stopped.

Many additional points of interest were brought out in the

discussion, which was participated in by Chairman S. W. Sparrow, C. H. Young and other members who propounded pertinent questions to which Mr. Herreshoff replied.

Prior to delivery of the address, the meeting elected A. W. S. Herrington, J. W. Henry, T. W. Smith, C. H. Warrington and Berton Bender as a committee to nominate Section officers for next year.

WHAT COMPOSES ALLOY-STEEL?

Pennsylvania Section Sees and Hears the Answer at Reading Meeting

On the afternoon of Dec. 8, 25 members and guests of the Pennsylvania Section journeyed via motorcoach to the plant of the Carpenter Steel Co., Reading, Pa. Here their number was practically doubled by members from other parts of the Section territory and the two parties spent an instructive and enjoyable 2 hr. in inspecting the plant. The party was divided into small groups, each having an individual guide who explained all steps in the process from the mixing of the charge of steel scrap and the various alloying elements; through the melting of the charge in a 6-ton Heroult three-phase electric furnace that uses 4000 amp. per phase at from 110 to 130 volts; the pouring of the molten metal, and the cropping, stripping and rolling of the ingots to give finished automotive steels in the form of bars, strips and wire. After the inspection was completed, the party adjourned to the Wyomissing Club for dinner and the meeting in the evening.

The paper at the evening session was by Dr. B. H. DeLong, chief metallurgist of the Carpenter Steel Co., and described the elements used in the manufacture of alloy-steels. Each of these was discussed with reference to (*a*) its origin, (*b*) method of production for use by the steel manufacturer, (*c*) method of addition to the steel, and (*d*) the qualities that it confers upon steel. For the convenience of the members this information is summarized in the accompanying table.

In concluding his paper Dr. DeLong urged that the engineers of the automotive industry cooperate with the steel maker by giving the latter the records of the successes or failures obtained with different alloy-steels. He also spoke of the necessity for further research work in connection with the testing and use of alloy-steels, mentioning the photo-elastic method and the work done by Professor Moore of the University of Illinois in connection with fatigue limits.

An interesting discussion, in which B. B. Bachman, of the Autocar Co.; E. W. Templin, of the Six Wheel Co.; J. Heber Parker, of the Carpenter Steel Co.; Charles O. Guernsey, of the J. G. Brill Co.; James R. Adams, of the Midvale Steel Co., and Dr. DeLong participated, followed the presentation of the paper. Some of the topics discussed were the use of alloy-steels for valves and valve tappets, whether the excellent results obtained with alloy-steels resulted from the properties of the alloying elements or the care exercised in the manufacture of the steel, the possibility of using stainless steel for pistons, whether the surface of the steel or the alloying element produced the property of stainlessness, the need for cooperation between the automotive engineer and the steel maker, fatigue resistance in steel, necessity for research work on the properties of manganese and molybdenum as elements entering into the manufacture of alloy-steel, and the factors influencing the cost of the product.

THE VARIOUS ELEMENTS

Element	Origin	Method of Preparation for Steel Maker
Iron	Oxide and sulphide ores containing from 40 to 60 per cent of iron from Wisconsin and Minnesota	Smelted in blast furnace to produce pig iron which contains about 95 per cent of iron and which is converted into steel by the Bessemer or open-hearth processes and refined further by the electric furnace or crucible processes
Carbon	Widely distributed	
Nickel	Arsenate, silicate, oxide, sulphate, and sulphide ores. The last from the Sudbury district of Ontario is principal source	Roasted to remove arsenic or sulphur; smelted in blast furnace; resmelted in electric furnace
Sulphur	In iron ore	
Phosphorus	In iron ore	
Silicon	Widely distributed as sand and quartz	
Manganese	Oxide ores from Brazil, India and Russia	Smelted in blast furnace; product contains 80 per cent of manganese and 6½ per cent of carbon; refined further in electric furnace to give a product containing 95 per cent of manganese and 2 per cent of carbon
Molybdenum	Ore from Colorado and Arizona	Mechanical concentration; chemical refinement and combination with lime
Vanadium	Ores from Peru and Colorado	Mechanical concentration; chemical refinement and electric furnace smelting
Chromium	Oxide ore called chromite from New Caledonia, Rhodesia and India	Smelted in electric furnace to produce ferrochromium containing 70 per cent of chromium and 0.05-7.00 per cent of carbon

In connection with this last point Mr. Parker mentioned the wide range in the cost of the various elements, from 3 or 4 cents per lb. for manganese and silicon to $4 for vanadium, stating that the sum of the prices of the various elements would not give the cost of making a given quantity of alloy-steel. Emphasizing this fact, he pointed out that each alloying element had its own peculiar mill problems, such as different methods of furnace control, individual cooling rates and a yield from the ingot varying from 55 to 75 per cent, and in addition research work and metallurgical supervision on the part of the steel maker had to be paid for by the customer.

Business Meeting

At the business meeting that preceded the reading of Dr. DeLong's paper, G. Walker Gilmer, Jr., was named as the representative of the Section on the Society's Section Committee for the next administrative year with A. K. Brumbaugh as alternate. The committee to nominate officers of the Section for the coming year were also elected at the meeting. Those named to serve on this committee were: B. B. Bachman, E. L. Clark, G. Walker Gilmer, Jr., George C. Lees and Russell Hoopes.

PROFIT-PAYING AIRPLANES

Commercial Utilization of Aircraft Explained to New England Section

The time having arrived when engineers have practically completed the development of both the engines and the planes, the task now remains to make them render the service for which they were intended, in other words, to make them profit-paying investments. Discussing the subject, Profit-Paying Airplanes, Charles G. Peterson, engineer of the Wright Aeronautical Corporation, Paterson, N. J., enlivened the regular monthly meeting of the New England Section on Dec. 4 at Boston, and entertained the members of the Section and their guests with a description of the varied uses to which modern airplanes have been put in fulfilling their function of performing profitable commercial service.

In addition to their best known uses, of carrying passengers and transporting mail and express packages, their other functions, said Mr. Peterson, may be roughly divided into (*a*) advertising, which includes daytime skywriting and flying by both day and night with large signs painted on the wings; (*b*) aerial photography, including map-making, contour work and sketching; (*c*) forestry work, including timber cruising, fire patrol and fire suppression; (*d*) crop protection, including the dusting of cotton fields for the purpose of destroying boll weevils; and (*e*) mosquito control, by dusting swamp lands in a similar manner.

Mail carrying has been the most profitable. Then came sky-writing. When the first sky-writer wrote the telephone number Vanderbilt 7100 in the sky, the calls for that number were so numerous that they put the hotel telephone exchange out of business.

Sky-Writing Advertising

Through records of sales in Philadelphia and Pittsburgh, said Mr. Peterson, the American Tobacco Co. has found that, as a result of their sky-writing advertising campaign, the sales of Lucky Strike cigarettes increased 38 per cent. The company was said to have entered into a $1,000,000 contract

PRESENT IN ALLOY-STEELS

Form Used for Addition to Steel	Method of Addition to Steel	Qualities Conferred upon Steel	Percentage
Scrap	Charged into electric furnace	High elastic modulus; strength; low coefficient of expansion; ductility and malleability, either hot or cold; strong magnetic properties	99 maximum
Charcoal; refined coal and coke; washed metal containing 96 per cent of iron and 4 per cent of carbon	Added to bath in electric furnace	Converts iron to steel	0.10-1.50
Shot or pigs containing 99 per cent of nickel	Charged into electric furnace	Gives toughness	1.00-3.75
		Makes steel hot short which is counteracted by manganese; increases machineability	0.03-0.05
		Makes steel cold short; produces good machining qualities	0.03-0.05
Ferrosilicon containing approximately equal amounts of iron and silicon	Added to bath in electric furnace as coarse lumps or powder	Frees steel of gases or oxides; increases depth of penetration of hardness in carbon tool steel	0.05-2.00
Ferromanganese		Produces hot malleability by eliminating sulphur; large quantities give strength and toughness; frees steel from gases and oxides	1.25-1.80 usually 12-14 for long wearing steels
Calcium molybdenate	Added to bath, molybdenum enters steel and lime goes into slag	Not generally known	
Ferrovanadium containing 30 per cent of vanadium and 65 per cent of iron	Added to bath	Increases red hardness; adds toughness	0.15 to 0.19
	Added to bath in later stages of melting	Increases depth of penetration of hardness; gives added toughness to hardened steel	1.50-1.80 for gears, shafts, axles and ball roller bearings; 8-30 for stainless steel

for this advertising, the writer being paid $500 for each writing. As he wrote the words twice on each trip, he made $1,000 per flight. It was probable, said Mr. Peterson, that the airplane company made more than $500,000 profit on this contract. The drawback, however, was that the writer had to wait for a bright clear day on which to work.

Night advertising is exemplified by the manner in which the Pulitzer Cup Races were advertised recently in New York City. When the fleet of illuminated airplanes, followed by a pursuit plane, appeared over Times Square, everyone on Broadway stood still and watched them. Even the guests at the Aeronautic Dinner at the Hotel Astor left their seats to gaze at the spectacle.

The leader in daytime advertising has been the Ford Motor Co., whose airplanes have made two round-trips a day between Detroit and both Chicago and Cleveland since last April. The interest shown by farmers and others along the routes and the nature of their comments have caused dealers to express very favorable opinions as to the value of this advertising.

John Wanamaker is reported to have placed an order for five airplanes to be used similarly on flights between New York City and Florida. The Wanamaker company also has made an advertising point by buying the first Ford airplane and placing it on exhibition in its store. Employes of the store state that although an elaborate panorama is on display depicting historical scenes in New York City during the existence of the firm, which is now celebrating its 75th anniversary, visitors pass it by, but stop to inquire where the airplane can be seen; and a long line is constantly waiting to see it.

Aerial Photography and Map-Making

Among the leaders in map-making and aerial photography are the Fairchild Aerial Survey of New York City and the Brock Co. of Philadelphia, many manufacturing companies having become interested in having aerial views made of their plants. The Government is using its own airplanes extensively for map-making. If these contracts should be let to private organizations, said Mr. Peterson, they would be exceedingly profitable.

The number of newspapers specializing in photographic illustrations is increasing enormously. In case of accident, a great effort is made to get photographers to the scene as soon as possible and to get the photographs back to New York City. One pilot, who is also a photographer, takes photographs but does not develop them, dropping the films by a parachute into Battery Park, where his assistants receive them. When necessary, a cabin can be fitted up and the films developed en route.

Excellent work has been done in forest fire-patrol work ever since the war. About 80 per cent of the Canadian Air Force is said to be engaged in this work, the cost of which is only a small fraction of that of the older method. The Dominion Government, said Mr. Peterson, has developed an airplane called a fire-suppression plane, which carries fire-fighters armed with fire extinguishers, who go to work just like any other well-trained fire company. Several firms are now taking contracts for fire protection.

Crop Protection

In the last few years another form of service has been created, namely, crop protection, continued Mr. Peterson. In this work, the leaders are the Huff, Daland Dusters, Inc., who exterminate boll weevils by dusting cotton crops with calcium arsenate. Fourteen airplanes thus far have dusted about 60,000 acres, but this area is only about 0.3 per cent of the total acreage that should be covered.

Dusting with Paris green for exterminating mosquitoes has been used effectively by the Department of Agriculture, the cost when applied by airplane being about 20 cents per acre as against $5 per acre when done by hand.

The carrying of mail has recently received an impetus through the letting of additional contracts. Next will come express lines. If only a small fraction of the total amount of mail and express were sent by air, the transportation of it would be very profitable.

Passenger carrying for hire will come under three heads: (a) in lines operating on a definite schedule, (b) taking passengers up for a trip and (c) charging by the hour or by the mile. The danger of forced-landings is being overcome by the use of three 200-hp. engines, two of which are sufficient to enable the plane to fly and the use of only one will maintain it in flight. Sight-seeing flights by air-liners can thus be made safely which would otherwise be hazardous, as, for instance, those over the Everglades, the Grand Canyon and the like.

One of the things retarding the development of aeronautics is the lack of suitable landing-fields, added Mr. Peterson, but the National Aeronautic Association has done yeoman service in supplying this deficiency.

GASOLINE-ELECTRIC-DRIVE APPLICATIONS

Suitability for Motorcoaches and Commercial Vehicles Discussed at Cleveland

Detailed explanation of the considerations involved in the design of the electric unit of the gasoline-electric drive and discussion of the general design-factors relating to the engine unit occupied the attention of the 180 members and guests who attended the meeting of the Cleveland Section held in the assembly hall of the Hollenden Hotel, Cleveland, on Dec. 14. At the dinner that preceded the technical session, 80 covers were laid.

A lively discussion followed the presentation of the paper, which was entitled Gasoline-Electric Hook-Up and was by E. M. Fraser, consulting engineer, Yonkers, N. Y. One of the participants was J. C. Thirlwall, of the railway engineering department of the General Electric Co., Schenectady, N. Y., who commented at some length on the application and operation of the designs referred to by Mr. Fraser.

At the business session held in conjunction with the meeting, Ernest Wooler, automotive engineer for the Timken Roller Bearing Co., Canton, Ohio, was elected Sections-Committee representative for 1926, and A. J. Scaife, chief factory service-engineer for the White Motor Co., Cleveland, was named as alternative representative.

The appointment by the chairman of members of a committee to nominate Section officers was announced. This committee is constituted as follows: A. J. Scaife, W. E. England, S. L. Bradley, F. W. Slack, and E. W. Weaver.

PROBLEMS OF FLEET OPERATION

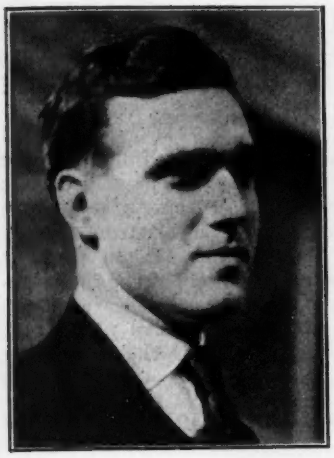
Some of the problems encountered in the operation of fleets of motor vehicles, as dealt with in a paper prepared by Harold Jarvis, manager of the Transportation Guarantee Co., constituted the topic for consideration and discussion at the regular monthly meeting of the Northern California Section at the Engineers Club, San Francisco, on the evening of Dec. 29, following a dinner of the attending members.

ROAD-TRIAL FACILITIES AND PROCEDURE

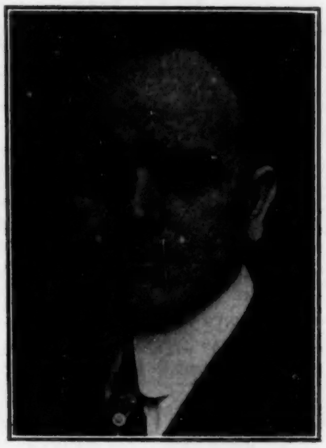
General Motors Proving Grounds Illustrated and Described to Dayton Section

Activities at the proving grounds of the General Motors Corporation near Detroit include the carrying on of endurance tests and experimental-car operation by each division of the Corporation, and the comparative engineering and edurance tests of such cars in current production as may be of interest. In the paper that he presented at the meeting of the Dayton Section held on Dec. 16, which is printed in full elsewhere in this issue of The Journal, O. T. Kreusser, director of the proving grounds, exhibited many lantern-slide views, enumerated the various tests and stated the details of the methods of test procedure.

At this meeting, Vincent Apple was elected Section representative on the Sections Committee. The members elected to be the Nominating Committee were Joseph Beeck, W. A. Chryst, Ernest Dickey, F. W. Heckert and Thomas Midgley, Jr.



O. T. Kreusser



L. S. Keilholtz

At a subsequent meeting of the Governing Committee of the Section which was held on Dec. 19, the resignation of O. T. Kreusser, tendered subject to acceptance by the Committee because of his having removed to become director of the General Motors Corporation proving grounds, Milford, Mich., was declined, and Mr. Kreusser remains officially Chairman of the Dayton Section. In place of H. W. Asire, the former Vice-Chairman who transferred his business activities to Detroit, the Governing Committee appointed Lester S. Keilholtz, chief engineer of the Delco-Light Co., Dayton, to be Vice-Chairman of the Section.

DUESENBERG TALKS OF ENGINES

Present and Probable Developments Told at Chicago Section's Best Meeting

Fred S. Duesenberg was the drawing card that made the Dec. 18 meeting of the Chicago Section the best it has ever held. Sixty-two members and guests sat at the dinner in the Chicago Engineers Club that preceded the technical session. Among those present at the table were Mr. Duesenberg, who had just returned from California; C. C. Hanch, an old personal friend who introduced the veteran racing car and engine builder to the assemblage; Paul Geyser, of the Yellow Cab Mfg. Co.; R. H. Croninger, assistant to the vice-president of the Yellow Truck & Mfg. Co.; S. M. Havens and Mr. Southerland, of the Wyman-Gordon Co., and Robert E. Wilson, of the Standard Oil Research Laboratory.

Frederick S. Duesenberg

The attendance at the technical meeting, particularly of young men, was unusually large as a result of the energetic efforts of Lee W. Oldfield, chairman of the Membership Committee of the Section, and Chairman Walter J. Buettner reports his confident expectation that the excellent assistance given by the various committees will aid in breaking the attendance records for the next three Section meetings and bring many new members into the Society.

In opening the meeting, the reading of committee reports was dispensed with and the meeting proceeded at once to the election of a representative on the Sections Committee of the Society and a nominating committee to offer names for Section officers for 1926. Taliaferro Milton was elected to the former office and Robert E. Wilson, Frank C. Mock, Benjamin S. Pfeiffer, Lee W. Oldfield and J. S. Erskine were chosen for the nominating committee.

The address by Mr. Duesenberg, which was given in an informal way, dealt with current types of commercial high-efficiency engine and the influence upon them of innovations introduced and proved on racing cars, and also with the trend that will be followed in commercial practice in the next few years, showing that the innovations of one year in racing engines are incorporated in commercial engines the following year. The talk brought forth numerous questions from the hearers and the interest was so keen and sustained that the meeting was protracted until 10.40 p. m.

MOTOR-TRUCK MAINTENANCE DISCUSSED

Metropolitan Section Hears Three Practical Papers on Important Problem

One of the most interesting meetings held this year by the Metropolitan Section was that on Dec. 17 at the Building Trades Club, which was addressed by F. E. Hatosy, superintendent of maintenance of the Motor Haulage Co., Inc., Brooklyn, N. Y.; Henry G. Fallerius, superintendent of motor vehicles, Bloomingdale Bros., Inc., New York City; and Chester W. Sater, superintendent of transportation of the Great Atlantic & Pacific Tea Co., Jersey City, N. J. The meeting was especially noteworthy because of the extensive and valuable discussion that was contributed by a large number of persons engaged in motor-truck operation.

Hatosy on Inspection

Basing his remarks upon the premise that, when properly applied, inspection of motor vehicles is far more effective toward attaining efficient and economical fleet maintenance than any other form of shop effort or supervision, F. E. Hatosy delved into the important factors that make or mar the effectiveness of any inspection system. He stated that in determining inspection intervals it is necessary to take into account six factors, namely, the make and type of vehicle, type of operator, mileage covered, topography of route, recurrence of breakdowns as shown by previous experience, and length of time for body and chassis bolts to become loose.

The speaker went into considerable detail in stating how these individual items affect the inspection period in actual practice. He stated that it is extremely important to choose properly the system of inspection, so as to insure a satisfactory flow of work and the avoidance of so-called "temporary" or "good-enough-for-a-couple-of-days" jobs. Complete overhauling was said to be seldom necessary when proper inspection methods are applied.

Mr. Hatosy concluded his paper with a typical example of the results of an inspecton covering approximately 200 parts of a vehicle. He also mentioned the way in which accessibility of design has an important bearing on maintenance cost.

Unit Replacement versus General Overhaul

H. G. Fallerius in a very instructive paper divided the problem of motor-truck maintenance into three parts, namely, minor repairs, major repairs and rebuilding or general overhaul. Classified under minor repairs were small items including adjustments that could be applied in the field. Major repairs come under the category of central shop work. Rebuilding and general overhaul means making good trucks out of old ones.

Continuing his address, Mr. Fallerius recalled that 10 or 15 years ago the process of general overhaul was considered good practice and that in those days the typical fleet of trucks was made up of a large number of different models. More recently, however, the value of standardization has made itself felt until we find large groups of trucks of the same model, thus making possible the application of the unit replacement system.

In actual practice with the unit-replacement system, the stockroom is equipped with complete units in good repair, such as engine, clutch, transmission, differential, steering

post, and possibly a front-axle assembly. It is possible to draw from this stock as need arises and, by replacing the unit rather than individual parts, at least a 50-per cent time-saving is effected over the old general overhaul method.

In conclusion, Mr. Fallerius gave some interesting figures concerning the requirements for unit replacement among certain groups of trucks. For example, a certain group of 2-ton trucks, 150 in number, required four differential assemblies, four rear ends complete, two transmission and clutch assemblies, one steering post assembly and three engines, constituting a total investment of $2,660.41. The investment cited for a group of one hundred 3½-ton trucks was $1,768, and that for a group of fifty 3½-ton trucks was $1,231. It was stated that with the unit-replacement system the truck could be replaced in service within 24 hr. after being brought to the repair shop.

Time for Truck Replacement

Introducing his address on the topic, When Should a Truck Be Retired, Chester W. Sater decried the lack of accurate evidence applying to costs of truck operation. He felt that the Society would be an admirable agency for developing a definite procedure covering the compilation and application of trucking costs.

Continuing, the speaker stated that obsolescence would appear to be an important factor limiting the useful life of a truck. In other words, a period is reached at which the vehicle ceases to become an economically sound proposition in comparison with newer models, this applying especially to cases where certain models have been discontinued.

It would seem better practice, stated Mr. Sater, to regard the operating cost per mile rather than the increased cost of repairs alone as the index of a truck's efficiency. By proper overhauling, old trucks can often be made to operate efficiently and economically in comparison with newer models. As an example, a certain fleet purchased between 1914 and 1919 was said to show an operating cost per mile only approximately 2 cents higher than that shown by 2-year-old vehicles, practically all the older trucks having covered more than 100,000 and the newer ones approximately 25,000 miles.

In conclusion, Mr. Sater compared the cost of the practice of overhauling at intervals of 39,000 miles with the practice of exchanging the used vehicles for new ones every 4 years at an allowance of $2,000 for a 5-ton truck. It was shown that an $800 saving would be effected by the method first mentioned. The conclusions drawn from the analysis were stated by the speaker as follows:

> The principle of operating a truck until it becomes obsolete can be satisfactorily followed, provided it is properly maintained up to that time. Serious accidents, involving the replacement of major parts such as frames, axles, crankcases and the like, or neglect, which is equivalent to improper maintenance, would certainly increase the cost of repairs to the extent of making earlier retirement desirable. Except in rare instances, in a properly maintained fleet, major replacements are unnecessary; so, given proper maintenance, no good reason for the retirement of a truck before it is obsolete could be urged. Knowing when a truck is obsolete depends on knowing costs and, since no uniform cost system is in general use by which operators of trucks can compare costs and performances, it is felt that the development of such a system by the Society of Automotive Engineers would meet as important a need of the operators of trucks as have been many of the services rendered by the Society to the automotive industry in general.

Among those who participated in the very lively discussion that followed were A. F. Masury, R. E. Plimpton, W. E. Kemp, C. O. Bech, H. G. McComb, John F. McMahon, E. B. Neil, L. T. Hanford, and G. A. Round.

C. B. Veal was duly elected to represent the Metropolitan Section on the Sections Committee of the national Society. The resignation of P. M. Heldt from the Governing Board was accepted with regret, Mr. Heldt having removed from New York City to Philadelphia. W. E. Kemp was chosen to fill the vacancy made by the resignation of Mr. Heldt.

FINISHING CYLINDER BORES

Grinding, Reaming, Lapping and Honing Discussed by Detroit Section

The comparative advantages of grinding, reaming, honing and lapping cylinder bores in producing the most desirable finish resulted in an instructive meeting replete with keen discussion at the semi-monthly session of the Detroit Section on Dec. 17. Representatives of the Chrysler, Wilson Foundry & Machine, Continental, Oakland, Dodge, Lincoln, Paige-Detroit, Hupp, White and Buick Companies presented short statements of the experiences of their respective plants and additional information was brought out in the discussion that followed. L. C. Hill presided.

Lapping Practised by Chrysler, Wilson and Continental Companies

The Chrysler Corporation, said C. A. Bolus, decided, after a period of experimentation, that lapping would produce at lower cost a better finish than had been obtained by grinding, and would have the additional advantage of avoiding the necessity for keeping skilled operators on the finishing operation. For a time, grinding of the cylinder-blocks of certain engines was continued but, a few months later, the practice of lapping was fully adopted.

Cylinders are lapped in two operations, roughing and finishing, he said, the type of lap being the same except for the length and shape of the stones on the cutting surfaces. Roughing stones have a concave surface, finishing stones, convex. The quality of the latter is also finer. The amount of material removed depends on the condition of the reamed surface and varies from 0.0005 to 0.0015 in. The surface must be smooth, within close limits as to out-of-roundness, and without taper.

Experience has proved, continued Mr. Bolus, that engines with lapped cylinders leave the running-in stands with the bores in a very satisfactory condition. As the investment in lapping equipment is only a fraction of that required for grinding and the saving in direct labor cost is so great, he believed that the changes in the methods of machining that were effected constitute one of the outstanding contributions toward economy in production.

The Wilson Foundry & Machine Co., said F. N. Thiefels, has been lapping cylinder bores continually since 1921 and still employs the original method. Not so much attention is paid to the lapping process as to the preparation of the bores before lapping. Lapping then becomes merely smoothing, during which approximately 0.0005 in. is removed and for which from 15 to 20 sec. is required. Bores that exceed 0.0005 in. in out-of-roundness or 0.0005 in. in taper are salvaged on a single-spindle vertical drilling-machine in which is used a Hull lap that expands equally on all hones and removes a certain percentage of taper or out-of-roundness.

After experimenting with various other types of lap and hone, Mr. Thiefels believed that the cost of lapping would be greatly increased with their adoption and that the accuracy of the boring operation would be decreased. A lapping machine of the company's own design is employed, one of the features of which is the use of a heart-shaped or constant-speed cam for the stroke of the head that carries the laps. It is said to be superior to a crank motion, for it eliminates the dwell at the end of the stroke that has a tendency to bell-mouth the bores. Approximately 250 cylinder-blocks can be lapped on each set of hones at a cost, including labor, of 5 cents per block. Knight engine sleeves require from 30 to 45 sec. to lap, depending on the amount of stock to be removed. From 0.0005 to 0.0010 in. is allowed. The cost of lapping is approximately 1½ cents per sleeve or a combined engine cost of 15 cents for 12 sleeves.

A. H. Fors, of the Continental Motors Corporation, explained in detail the disadvantages that had been found with

(*Continued on p. 26*)

STANDARDIZATION ACTIVITIES

The work of the Divisions and Subdivisions of the S. A. E. Standards Committee and other standards activities are reviewed herein

STANDARD BUMPER-HEIGHT NEEDED

Joint Committee To Be Appointed To Establish Single Standard for All Vehicles

At a meeting of the Truck Division during the Automotive Transportation Meeting in Philadelphia, the need for a standard bumper-height for front and rear motorcoach bumpers and for front motor-truck bumpers was emphasized. The present S.A.E. Standard for passenger-car bumpers specifies a front-bumper height of 20 in. and a rear-bumper height of 21 in., these heights having a tolerance of plus or minus ⅜ in. for each inch of effective bumper-face. A survey of current practice for motorcoach and motor-truck bumpers indicates the possibility of establishing a single standard height that, provided a wide-faced bumper were used, would assure bumpers on different types of vehicle meeting. It was felt that this matter is of sufficient importance to warrant appointing a Joint Subdivision consisting of representatives of the Passenger-Car, the Motorcoach, the Truck and the Parts and Fittings Divisions. M. C. Horine, of the International Motor Co., was designated as the representative of the Truck Division.

TO STANDARDIZE PINS AND WASHERS

Organizing Sectional Committee to Reduce Number of Varieties and Sizes

The Society has asked that it be designated by the American Engineering Standards Committee as one of the sponsors for the Sectional Committee on Pins and Washers that is being organized under the procedure of the American Engineering Standards Committee by the American Society of Mechanical Engineers. The task of the Committee is to establish an American Standard for various types of pins and washers used in mechanical constructions. There are at present three S.A.E. Standards in the S.A.E. HANDBOOK for these parts, namely, Cotter-Pins, p. C7; Lock-Washers, p. C5; and Plain Washers, p. C5a, which it may be expected will be considered by the Sectional Committee in formulating a general American Standard.

Data recently available regarding the quantity and value of the lock-washers purchased by the automotive and other industries indicate an astonishing preponderance of the automotive product. Lock-washers used by the automotive industries are almost entirely in the smaller sizes, whereas many of those used by other industries, including the railroads, are in much larger sizes. It has been stated that the lock-washers used by the automotive industry are largely inferior to those used by others. If this is true, it is probably because large quantities of them are bought and sold by garages, service-stations and merchants dealing in packages of selected sizes without a knowledge of the proper design and function of these small but important parts. The following figures indicate the tremendous growth in the manufacturing of lock-washers due to the automotive industry.

	Number	Invoice Value
65 PER CENT OF CONSUMPTION, FIRST 9 MONTHS OF 1925		
Automotive Industry	1,669,356,185	$1,097,026.00
Other Industries	41,751,227	447,030.00
ESTIMATED TOTAL FOR 1925 BASED ON THE FOREGOING FIGURES		
Automotive Industry	3,250,000,000	$2,230,000.00
Other Industries	85,500,000	915,000.00

On this basis the automotive industry consumes 97.5 per cent of the total number of lock-washers sold, at a cost of 71 per cent of the total invoice value. The average cost of automotive lock-washers is about 15 for 1 cent, while other industries pay an average of nearly 1 cent per washer.

DEPRESSED-BEAM STANDARD APPROVED

General Meeting Adopts Definite Requirements as Interim Specification

As a result of a general meeting called by the Research Subcommittee on Head-Lamp Illumination and attended by representatives of passenger-car and lamp manufacturers, as well as by members of the Illuminating Engineering Society's Committee on Headlighting Specifications, illumination specifications for head-lamps equipped to give a depressed as well as a normal beam were endorsed as an interim or temporary specification.

These provisions were taken from the suggested vehicle-lighting provisions submitted under date of Nov. 3, 1925, by the Automotive Lighting Association to the Committee on Uniformity of Laws and Regulations of the National Conference on Street and Highway Safety. A detailed account of the meeting will be found in the Automotive Research section of this issue on page 25.

PROPER TIRE-SPACING MOOTED QUESTION

Makers Believe Center-to-Center Spacing of Dual Type Should Permit Oversizing

Tire designers have repeatedly stated that many present-day motorcoaches equipped with dual pneumatic tires are undertired. Moreover, rim spacings have been selected by motorcoach engineers that do not permit the use of tires one size larger than the initial equipment, should operating conditions warrant it. The practice of undertiring, with no provision for oversizing, results in unnecessary tire trouble, low mileage per tire and an unnecessarily high tire cost for the entire life of the vehicle.

Motorcoach engineers argue against wider rim-spacing and larger tires because of the wheel bearing, axle and body problems. These problems are important, but it should be remembered that the cost of tires necessary for the life of a motorcoach is equal to the original price of the motorcoach and therefore anything affecting this item from 25 to 50 per cent should receive careful consideration.

The foregoing remarks are abstracted from a written discussion of dual-tire spacing submitted by Burgess Darrow at a joint conference of the members of the Motorcoach, Truck and the Axle and Wheels Divisions, representatives of tire companies and others interested, held in Philadelphia on Nov. 12 to discuss standardization of the center-to-center spacing for dual pneumatic tires. A decided difference of opinion with regard to providing for the use of oversize tires in the original vehicle design was evidenced. In general, the tire manufacturers preferred a standard that would permit oversizing without necessitating a change in wheels, while the vehicle and axle representatives preferred a standard that would specify the proper tire-size for original equipment, with no provision for subsequent oversizing.

Representatives of the tire makers maintained that their experience indicates that too frequently the vehicle operators

must re-tire their vehicles to take care of overloads that are commonly carried and that in many cases this involves changing wheels, and that the adoption by the industry of a table of standard center-to-center spacings that would permit mounting the next larger size tires on the same rims would overcome the trouble now experienced.

On the other hand, it was felt generally by the vehicle builders that the adoption of such a standard would involve too many alterations in major mechanical features of the vehicle and that standard center-to-center mounting dimensions without allowance for tire oversizing would be more acceptable to them.

In reviewing the situation, B. B. Bachman stated that the problem is due largely to conflicting conditions affecting the vehicle and tire manufacturers and indicated the futility of trying to solve it by merely adopting a standard, particularly if it is one that would not be practical and acceptable to all interests. He thought also that the problem is very largely a commercial one and would have to be solved in part by the various interests involved. He suggested that it might be well to approve a table of definite tire and rim sizes and spacings as proper for the vehicle builders to select from with the understanding that if such initial equipment is not properly selected, the responsibility should rest on the vehicle builder. After discussion the accompanying table of center-to-center spacing for dual pneumatic tires was adopted by a vote of 13 to 10.

RIM CENTER-TO-CENTER SPACING FOR DUAL PNEUMATIC-TIRE MOUNTINGS

Type	Tire Size, In.	Rim Size, In.	Rim-Center-to-Center Spacing, In.	Load per Tire, Lb.	Possible to Oversize
High Pressure	5[a]	5	7¾	1,250-1,700	Yes
	6[a]	6	7¾	1,700-2,200	No
	6	6	9	1,700-2,200	Yes
	7[a]	7	9	2,200-3,000	No
	7	7	10¼	2,200-3,000	Yes
	8[a]	8	10¼	3,000-4,000	No
	8	8	11½	3,000-4,000	Yes
	9[a]	8	11½	4,000-5,000	No
Balloon	6.75[a]	6	9	1,300-1,700	Yes
	7.50[a]	7	9	1,700-2,100	No
	7.50	7	10¼	1,700-2,100	Yes
	8.25[a]	7	10¼	2,100-2,500	No
	8.25	7	11	2,100-2,500	Yes
	9.00[a]	7	11	2,500-3,000	No

[a] Sizes included in minority report.

For motorcoaches, the load per tire shall be figured with all seats filled and for motor trucks it shall be figured with the full rated-load.

Following this action, objection was raised to sending out only a majority report and it was decided to issue a minority report listing the sizes as given in the majority report except that the optional spacings permitting oversizing are omitted. The sizes included in the minority report are indicated in the accompanying table. It was generally agreed that the two recommendations should be submitted to the industry to determine whether a preponderance of opinion in favor of one of the proposals exists and that, if possible, a definite report should be submitted for consideration at the Standards Committee meeting in January.

TIRE "STANDARDIZATION" IN RUSSIA

Non-Standard Sizes Prohibited by Decree of Council of Labor and Defence

The accompanying copy of the decree of the Russian Council of Labor and Defence, definitely prohibiting the use of non-standard tire sizes, will be found of considerable interest, possibly not as a matter of concern in American manufacture, but as of value in showing the standards procedure followed in Russia. The decree is printed in the June 13, 1925, issue of the *Torgovo Promishlennaya Gazeta* (Commercial and Industrial Gazette), Moscow.

It is understood that for the time being the original standard sizes listed in the decree are not adhered to strictly, orders having been received after the passage of this decree by the Amtorg Trading Corporation, the buying agency for the Russian Government in this Country, for tire sizes other than those mentioned.

Decree of the Council of Labor and Defence Concerning the Standardization of Tires

The Council of Labor and Defence decrees:

(1) With a view to attaining greater uniformity of pneumatic tires for light automobiles and trucks and motorcycles, as well as for the purpose of rationalization and cheapening the production of automobile and motorcycle tires, that henceforth the following standard list of types and sizes of automobile and motorcycle tires shall be established:

I.—Pneumatic Tires

(The first two figures designate the tire size, the third the diameter of the rim.)

Clincher Tires	Metric Tires
26 in. x 2½ in. x 410 mm.	710 x 90 x 508
28 in. x 3 in. x 558 mm.	765 x 105 x 554
30 in. x 3½ in. x 585 mm.	820 x 120 x 562
	820 x 135 x 562
	815 x 105 x 609
Straight-Side Tires	880 x 120 x 625
32 x 4½ x 23 in.	880 x 135 x 625
	920 x 120 x 660
	920 x 135 x 660

II.—Solid Tires

American Sizes	Metric Sizes
34 x 4 x 28 in.	880 x 120 x 721
36 x 4 x 30 in.	900 x 120 x 741
36 x 5 x 30 in.	930 x 120 x 771
36 x 6 x 30 in.	1,010 x 120 x 850
40 x 5 x 34 in.	1,030 x 140 x 850
40 x 6 x 34 in.	1,050 x 120 x 881
	1,060 x 120 x 902

(2) The building of passenger automobiles and trucks, as well as of motorcycles, with wheels requiring tires not enumerated in Section I of the present decree is hereby prohibited.

(3) The Commissariat of Foreign Trade shall permit the importation from abroad of only such automobiles and motorcycles, the wheels of which correspond to the sizes of tires named in the present decree. The importation of tires for automobiles and motorcycles with wheels of other dimensions than decreed shall be permissible only in cases of emergency with the concurrence of the Commissariats of the Ways of Communication, of Foreign Trade, the Supreme Council of National Economy of the U. S. S. R. (Division of the Rubber Trust) and the Commissariat of the Army and Navy.

(4) The Supreme Council of National Economy of the U. S. S. R. shall continue to manufacture tires of non-standard sizes as long as passenger automobiles, trucks and motorcycles with rims requiring non-standard sizes of tires shall be in operation on the territory of the U. S. S. R., that is, up to the complete wearing-out of the automobiles and motorcycles mentioned.

(5) To allow the presidium of the S. C. N. E., on concurrence of the Commissariats of Foreign Trade of Ways of Communication and the Commissariat of the Army and Navy at the request of services and institutions, organizations and individuals, to amend the list of standard tires (Section I) through changes and supplements provided that all additions to it shall be made only in case they can be produced or imported in quantities of not less than 60 tires.

Amendments and supplements of the list shall be published by the presidium of the S. C. N. E. of the U. S. S. R.

STANDARDS COMMITTEE DIVISION REPORTS

The following Division Reports will be submitted to the Standards Committee for approval at the Summer Meeting

STANDARDS COMMITTEE MEETING JAN. 26

Will Be Held at Detroit in Connection with Annual Meeting of Society

Twenty-nine recommendations will be submitted to the Standards Committee for disposition at the 1926 Annual Meeting, which will be held at the General Motors Building on Tuesday, Jan. 26.

The recommendations to be acted upon are reviewed in this section of THE JOURNAL in order that those interested may have sufficient time to study them before the Standards Committee Meeting. Non-members of the Standards Committee or of the Society will be welcome at this meeting, which will be in the nature of a public hearing, and their comments on the Division recommendations will receive careful consideration.

The recommendations approved by the Standards Committee will, in accordance with the Standards Committee Regulations, be submitted for a letter ballot of the voting members of the Society before becoming official S.A.E. Standards and Recommended Practices.

REVISED BEARING-NUMBERS PROPOSED

New Numbers Permit Ready Identification of All S.A.E. Standard Bearings

In the present S.A.E. Standards for Ball Bearings, the 200, 300 and 400 series are used to designate the single-row, the double-row radial and the angular-contact types of ball bearing. In order that there might be a standard system of designating ball-bearing types which would permit absolute identification by the S.A.E. bearing-number, the Ball and Roller Bearings Division has recommended that the present bearing numbers be revised as indicated in the following table:

Type	Present Series	Proposed Series
Separable (Open) Type	5 to 19	5 to 19
Extra-Small Series	9430 to 9435	34 to 39
Radial, Light Series	200	200
Radial, Medium Series	300	300
Radial, Heavy Series	400	400
Wide-Type, Light Series	200	5200
Wide-Type, Medium Series	300	5300
Wide-Type, Heavy Series	400	5400
Angular-Contact Type, Light Series	200	7200
Angular-Contact Type, Medium Series	300	7300
Angular-Contact Type, Heavy Series	400	7400

The Division action in this connection was based on the report submitted by a Subdivision that had been appointed to make a study of the present numbering system and to recommend proper changes. This Subdivision consisted of E. R. Carter, Jr., of the Fafnir Bearing Co., chairman; L. A. Cummings, of the Standard Steel & Bearings, Inc.; and T. C. Delaval-Crow, of the New Departure Mfg. Co. This Subdivision formulated its report at a meeting in New Britain on Sept. 30 and the report was acted upon by the Ball and Roller Bearings Division at a meeting in New York City on Oct. 16, 1925. In submitting the report, the following explanation was made by the Subdivision:

> The proposed numbering system leaves the use of letter suffixes for the individual manufacturer to indicate variations and modifications from standard types. For instance, a No. 205 bearing in the type using the maximum number of balls might be styled by one manufacturer as a No. 205-M and in the Conrad construction as a No. 205-C. Nevertheless, the bearing itself is the No. 205 standard size, as indicated by the number, positively identifying it as such according to the S.A.E. Standard dimensions. In other words, the internal construction, as developed by the individual manufacturer, need not have any influence on the standardized dimensions or the standardized designation.
>
> The Subdivision's recommendation is submitted to clarify a situation that is becoming more and more complicated and confusing as time goes on. The adoption of the proposed designations rests entirely with the individual ball-bearing manufacturers to be employed only when and if each individual manufacturer sees fit. It does, however, give a standard system of designating types from the engineering and the user's standpoint. Moreover, it properly classifies and designates any type that a manufacturer may produce in the future which is at the present time unknown to his manufacturing schedules.

Following the acceptance of this report, the Division approved the revised number series for adoption as a revision of the present S.A.E. Standards, but specified the 7000 series for the Angular-Contact Type instead of the 0000 series recommended by the Subdivision, eliminated the first two digits in the ball-bearing numbers for the Extra-Small Series and increased the last digit to correspond with the inside diameter, in millimeters.

TRACTOR BELT-SPEEDS REVISED

The present S.A.E. Standard for Belt-Speeds adopted in August, 1917, specifies that speeds of 1500, 2600, 3000 and 3500 ft. per min. shall be used, covering all practice. This standard was recently reviewed by the Agricultural Power-Equipment Division, which has recommended that the standard be revised to specify belt-speeds of 2600, 3000, 3250 and 3500 ft. per min. The speed of 3250 ft. per min. has been adopted as standard by the National Association of Farm Equipment Manufacturers. The 1500 ft. per min. belt-speed is not included as the need for it no longer exists.

TRACTOR-TESTING FORMS REVISED

At the Semi-Annual Meeting of the Society the report of the Agricultural Power-Equipment Division on Tractor-Testing Forms was adopted, but was withheld from publication in the S.A.E. HANDBOOK owing to the desire to correlate the correction factors used with those specified in the present S.A.E. Standard Engine-Testing Forms.

As a result of joint consideration by the Engine and the Agricultural Power-Equipment Divisions, it was decided that the correction factors used for the Engine-Testing Forms should be used also for the Tractor-Testing Forms to avoid confusion. The following changes in the original recommen-

dation on Tractor-Testing Forms were, therefore, recommended by the Agricultural Power-Equipment Division.

The correction factors in the present tractor-testing forms shall be changed from 28.60 in. of mercury at 70 deg. fahr. to 29.92 in. of mercury at 60 deg. fahr. and the basis of the belt-horsepower rating shall be changed from 90 to 85 per cent and the basis of the drawbar-horsepower rating from 80 to 75 per cent.

WIDE-TYPE BEARING WIDTHS INCREASED

Revisions Recommended as Result of Experience with Present Standard

In June, 1924, the Ball and Roller Bearings Division recommended as a result of an investigation by F. C. Hughes, of the New Departure Mfg. Co., that the widths of Bearings Nos. 200 to 205 inclusive should be increased.

The reasons given at that time for the increased widths recommended were:

The narrow widths do not allow sufficient center-to-center distance between the two rows of balls to accommodate separators of sufficient strength.

In some sizes the widths do not allow a race cross-section capable of withstanding the loads that the balls are capable of sustaining.

In some cases the increase in race cross-section allows an increase in the ball diameter, thereby increasing the carrying capacity of the bearings.

The revised widths were adopted as a revision of the S.A.E. Standard printed on p. C31 of the S.A.E. HANDBOOK.

Subsequent to this action it was found that the larger bearings also required an increase in the widths and Mr. Hughes served again as a Subdivision of one in determining the exact increases necessary for the different sizes. His recommendation was considered at the October, 1925, meeting of the Ball and Roller Bearings Division and adopted for submission to the Standards Committee.

The widths specified in the present standard, together with the widths now proposed by the Division, are given in the accompanying table.

WIDE-TYPE ANNULAR BALL-BEARINGS

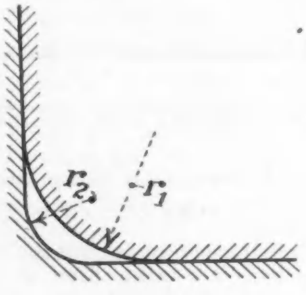
Bearing No.	Present Width, In.	Proposed Width, In.
206	3/4	15/16
207	7/8	1-1/16
208	1	1-3/16
209	1	1-3/16
210	1	1-3/16
211	1-3/16	1-5/16
212	1-3/8	1-7/16
213	1-3/8	1-1/2
214	1-7/16	1-9/16
215	1-7/16	1-5/8
216	1-5/8	1-3/4
217	1-3/4	1-15/16
218	2	2-1/16

BALL-BEARING CORNER-RADII INCREASED

Corner Radii Recommended Are within Radii Proposed for International Practice

Consequent upon the work of the American Sectional Committee on Ball Bearings, international agreement has been reached for the proper corner-radii of ball bearings. Two radii will be specified for each bearing; the maximum corner-radius on the shaft or in the housing and the minimum corner-radius on the bearing. It is the opinion of the Ball and Roller Bearings Division that for automotive practice it is unnecessary to specify both radii and the Division has, therefore, recommended that a single corner-radius be specified for each ball bearing, this radius to be the radius of the maximum fillet on the shaft or in the housing that will be cleared by the bearing.

It is felt that the bearing users are not interested in the actual dimensions that the bearing makers machine on the corners of the outer and inner races, known as r_1 in the proposed international standard, but that they are interested in the fillet that they could machine on a shaft or housing, this radius being known as r_2 in the proposed International Standard. These radii are illustrated in the accompanying illustration.



CORNER RADII KNOWN AS r_1 AND r_2 IN INTERNATIONAL PROPOSAL

It was thought also that sometimes it would be advantageous if the bearing maker could use a radius slightly different from the r_2 corner-radius, but as long as the corner relief incorporated in the bearing always cleared the shaft or housing fillet, no trouble would be experienced by the user and the bearing maker would be working under better manufacturing conditions.

The corner radii proposed by the Ball and Roller Bearings Division to supersede the present S.A.E. Corner-Radii are given in the accompanying table.

CORNER RADII PROPOSED AS STANDARD

Light Series No.	Light Series Corner Radius[1]	Medium Series No.	Medium Series Corner Radius[1]	Heavy Series No.	Heavy Series Corner Radius[1]
200	0.040	300	0.040		
201	0.040	301	0.040		
202	0.040	302	0.040		
203	0.040	303	0.040	403	0.040
204	0.040	304	0.040	404	0.060
205	0.040	305	0.040	405	0.060
206	0.040	306	0.060	406	0.080
207	0.040	307	0.060	407	0.080
208	0.060	308	0.080	408	0.080
209	0.060	309	0.080	409	0.080
210	0.060	310	0.080	410	0.120
211	0.060	311	0.080	411	0.120
212	0.080	312	0.120	412	0.120
213	0.080	313	0.120	413	0.120
214	0.080	314	0.120	414	0.120
215	0.080	315	0.120	415	0.140
216	0.080	316	0.120	416	0.140
217	0.080	317	0.120	417	0.160
218	0.080	318	0.140		
219	0.120	319	0.140		
220	0.120	320	0.140		
221	0.120	321	0.140		
222	0.120	322	0.140		

[1] The corner radius specified for ball bearings is the radius of the maximum fillet on the shaft or in the housing which will be cleared by the bearing.

ELECTRICAL NOMENCLATURE REVISED

The Electrical Equipment Division has recommended that the present S.A.E. Standard for Automobile Nomenclature, p. K1 of the S.A.E. HANDBOOK, be revised in accordance with the changes listed below.

Page K4, Group 1.—Change "Camshaft ignition-distributor gear" to read "Camshaft timer-drive gear"

Page K8, Group 2.—Change "Breaker-contacts" to read "Movable breaker-contact" and "Stationary breaker-contact"

Page K10, Group 2.—Insert, "Starting button" as third term to provide for mechanical or solenoid starting mechanisms

Insert, "Starting-ignition switch," to describe the type

of switch having a single lever that is turned to one position to crank the engine and to turn on the ignition. The lever in this type of switch is thrown back by a spring to the "Ignition-on" position as soon as the engine is started

Insert, "Current-voltage regulator" following "Voltage regulator" so as to include this type of regulator

INSULATION TEST VOLTAGE INCREASED

The Electrical Equipment Division has recommended that the present S.A.E. Standard for Insulation Tests of Electrical Apparatus, printed on p. B31 of the S.A.E. HANDBOOK, should be revised to specify a voltage range of from 6 to 40 volts instead of from 6 to 25 volts in view of the increase in the use of the 32-volt electrical systems on motorcoaches.

The present standard, adopted in January, 1914, revised as proposed, follows:

> Electrical apparatus for use on automotive vehicles, when operated on circuits of from 6 to 40 volts, shall be capable after installation of withstanding for 1 min. an alternating potential of 500 volts, the test being applied between the conducting circuit and the frame or ground. In the case of apparatus with one terminal grounded, the ground connection shall be removed at such a point as will permit the test to be applied to all parts of the circuit which, in actual use, will be subjected to working potential.
>
> Storage-batteries shall not be subjected to any insulation test above their working potential.

THREE SPARK-PLUG LENGTHS PROPOSED

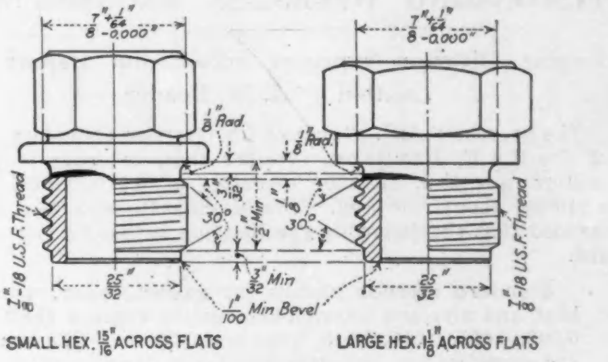
Present S.A.E. Standard for Spark-Plugs Revised and Extended by Engine Division

At the October meeting of the Engine Division the present S.A.E. Standard for Spark-Plugs was extended to include three skirt-lengths, an alternative terminal-thread, the maximum projection of the firing-points, and the minimum clearance dimension. The principal spark-plug dimensions revised and extended as proposed by the Engine Division are as follows:

> *Hexagon.*—All spark-plug shells shall have a hexagon of 15/16 or 1⅛ in. across the flats
>
> *Skirt Lengths.*—The distance from the gasket seat of the spark-plug to the end of the spark-plug shell, commonly known as the "skirt length," shall be ⅝, 13/16 or 1 in.; and the length of the thread for the ⅝ and 13/16-in. skirt-lengths shall be 9/32 in., now specified as minimum, and for the 1-in. skirt-length, 23/32 in.
>
> *Terminal Threads.*—The terminal threads shall be No. 8—32 or 0.183 in.—32
>
> *Firing Points.*—The maximum projection of the firing-points below the shell shall be 3/16 in.
>
> *Clearance.*—The minimum distance from the spark-plug seat to the nearest object over the spark-plug shall be 2¾ in.
>
> *Metric Spark-Plugs.*—The title for the present standard printed on p. A11 for "Aeronautic Spark-Plugs" shall be changed to "Metric-Type Spark-Plugs"

The Engine Division action was taken after a careful analysis of current practice, a summary of which was printed in the December issue of THE JOURNAL on p. 542.

The minimum clearance of 2¾ in. over the spark-plug seat



PRESENT S.A.E. STANDARD SPARK-PLUG SHELLS

is recommended to serve as a guide in designing parts located close to the spark-plug terminals; on the basis that short-circuiting will occur under certain conditions if metallic parts are located closer than proposed. This situation was covered also in the article appearing in the April, 1925, issue of THE JOURNAL on p. 411.

As revised, the S.A.E. Standard will specify seven sizes of spark-plug. The thread, the hexagon diameter and the skirt-length of the standard spark-plugs are given in the accompanying table.

Although the 1-in. skirt-length is not used extensively in present production, it is specified in view of the tendency in engine design toward smaller cylinders, making longer spark-plugs desirable to allow more room for the water-jacket.

PROPOSED S.A.E. STANDARD SPARK-PLUG SIZES

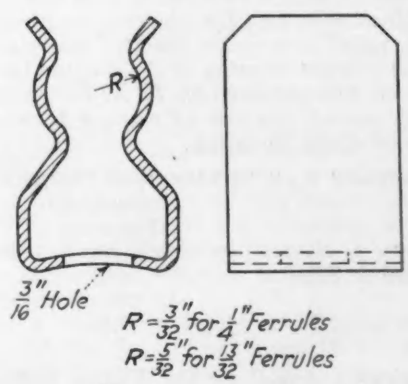
Thread	Hexagon	Skirt Length
⅞ in.—18	15/16	⅝
⅞ in.—18	15/16	13/16
⅞ in.—18	15/16	1
⅞ in.—18	1⅛	⅝
⅞ in.—18	1⅛	13/16
⅞ in.—18	1⅛	1
18 mm.—1½ mm.	1	9/16

FUSE-CLIP RADII SPECIFIED

Electrical Equipment Division Recommends Radii To Obtain Four-Point Contact

The present S.A.E. Standard for Fuses and Fuse-Clips, p. B32 of the S.A.E. HANDBOOK, specifies that clips shall be made so that fuses cannot slip out accidentally and shall be fastened to a base such that they cannot turn.

At the October meeting of the Electrical Equipment Division it was thought that the standard should specify a radius for that part of the clip which holds the fuse and that this radius should be slightly smaller than the radius of the ferrule on the fuse so as to obtain the four-point contact. It was, consequently, recommended that the present standard be revised to specify a 3/32-in. radius for ¼-in. ferrules, a 5/32-in. radius for 13/32-in. ferrules and a 3/16-in. screw-hole in the bottom of the fuse-clip, as shown in the accompanying drawing.



PROPOSED STANDARD FUSE-CLIPS

The Division recommended also that the voltage specified for lighting circuits be increased from 25 to 40, because of the increase in the use of 32-volt systems on motorcoaches.

These recommendations will be submitted for Standards Committee action at the January meeting.

PISTON-RING OVERSIZES RECOMMENDED

Engine Division Approves Subdivision Report Submitted by A. W. Reader

The present S.A.E. Standard for Oversize Cylinders, p. A7 of the S.A.E. HANDBOOK, specifies that, in order to obtain uniform practice, cylinder oversizes of 0.010, 0.020, 0.030, 0.040 in. should be used. The Engine Division has recommended that the following specification supersede this standard.

> Standard oversize pistons for passenger-car, motorboat and airplane internal-combustion engines shall be 0.003, 0.005, 0.010, 0.015, 0.020 and 0.030 in. The standard oversizes for motorcoach, tractor, truck and industrial internal-combustion engines shall be 0.010, 0.020, 0.030 and 0.040 in. Larger oversizes, when necessary, shall be held to multiples of 0.010 in.
>
> Piston-rings shall be held to the same oversizes, omitting the 0.003-in. oversize, as are specified for pistons.

This report was prepared by a Subdivision of which A. W. Reader, then of the General Motors Corporation, was chairman, the other members being R. J. Broege, of the Buda Co., and A. F. Milbrath, of the Wisconsin Motor Mfg. Co. The report was submitted to passenger-car and truck builders and met with general approval prior to the final Division action.

The work on this subject was instituted as a result of a conference, held in December, 1924, under the auspices of the Division of Simplified Practice of the Department of Commerce, of piston, piston-ring and passenger-car manufacturers. In the discussion at this Conference it was brought out that certain piston-ring manufacturers find it necessary to hold 4800 sizes in stock to meet current requirements. Although it was recognized that the piston-ring manufacturers were, in a certain measure, responsible for this uneconomical situation, it was appreciated that the recognition of standard oversizes by both automobile and piston-ring manufacturers would greatly improve conditions. It was decided to refer the problem to the Society with a request that the present S.A.E. Standard be revised to specify a series of oversizes that would meet all requirements for internal-combustion engines.

ENGINE-MOUNTING STANDARDS

Dimensions for Engine Trunnions Recommended by Engine Division

The adoption by the Society of the Engine Division recommendation covering engine trunnion dimensions will complete the specifications necessary for mounting engines. The recommendation, which is given in the accompanying table, was adopted at the October meeting of the Engine Division. The recommendation was prepared by A. A. Bull, it being based on a study of current practice of engines incorporating the trunnion-type of front mounting.

PROPOSED S.A.E. RECOMMENDED PRACTICE

Type	Trunnion Diameter In.	Minimum Trunnion Length, In.
Starting-Crank Bracket	2½	1¼
	3	1¼
Gear Cover	3¾	1½
	5	1½

The dimensions proposed by the Engine Division are intended for future practice only. The recommendation was submitted for criticism to all engine builders and passenger-car companies building engines and met with general approval, the comments received referring to special designs to which the proposed specifications were not applicable.

The Division report will be submitted at the January meeting of the Standards Committee for adoption as S.A.E. Recommended Practice.

CONE-CLUTCH FLYWHEEL DISCONTINUED

The Engine Division has recommended that the present S.A.E. Specifications for Cone-Clutch-Type Flywheels, p. A1b of the S.A.E. HANDBOOK, originally adopted by the Society in March, 1916, be discontinued owing to the fact that this type of clutch has become practically obsolete.

NO. 00 FLYWHEEL HOUSING ADOPTED

In response to the demand for internal-combustion engines of considerable power in industrial work, the Engine Division has recommended that the S.A.E. Standard for Flywheels and Flywheel Housings, p. A1 of the S.A.E. HANDBOOK, be extended to provide for still larger industrial engines than provided for by the No. 0 flywheel housing. The housing dimensions proposed are as follows:

PROPOSED DIMENSIONS FOR NO. 00 FLYWHEEL HOUSING

Inside Diameter, in.	31.000 to 31.010
Outside Diameter, in.	34¾
Bolt-Circle Diameter, in.	33½
Bolt-Holes	16
Bolt-Hole Diameter, in.	17/32

REVISED ENGINE NOMENCLATURE

The Engine Division has recommended that certain engine terms in the present S.A.E. Standard for Automobile Nomenclature be revised as specified below. These changes will be submitted for adoption at the January meeting of the Standards Committee.

Page K3, Group 2.—Omit the sentence reading "'Bushing' instead of 'bearing' for removable and renewable lining used in plain bearing"

In "Crankshaft front-bearing bushing" omit the word "bushing"

Following "Crankshaft front-bearing cap" insert "Crankshaft bearing-cap stud (screw or bolt)"

In "Crankshaft rear-bearing bushing" omit the word "bushing"

In "Crankshaft center-bearing bushing" omit the word "bushing"

In "Crankshaft second-bearing bushing" omit the word "bushing"

Page K3, Group 3.—Change "Flywheel studs" to read "Flywheel bolts"

Page K3, Group 4.—After "Starting-crank shaft" insert "Starting-crank shaft spring"

Page K5a, Group 1.—Substitute "Fan bracket" for "Stationary fan support" and "Fan spindle" for "Adjustable fan-support"

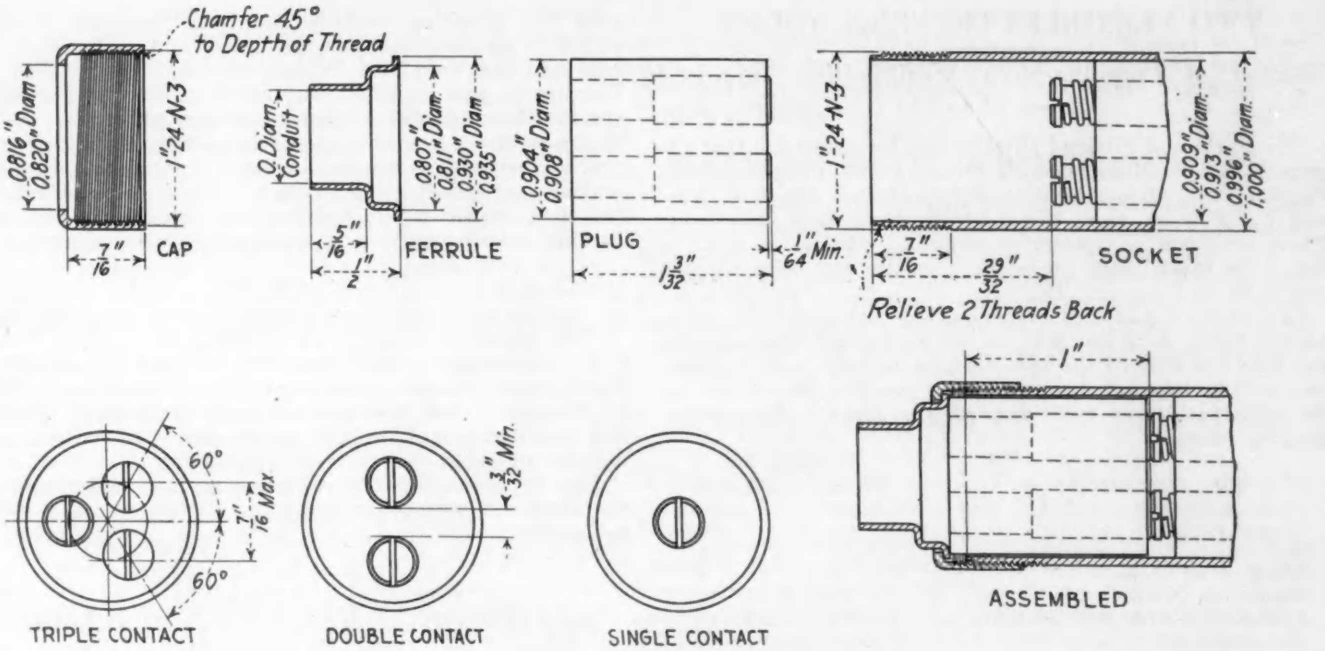
After "Fan hub" insert "Fan-hub bushing (or bearing)"

Page K6, Group 3.—At the end of this group add "Water-pump shaft bushing (or bearing)" and "Water-pump packing"

SCREW-TYPE CONNECTORS RECOMMENDED

Electrical Equipment Division Believes Bayonet-Type Unsuited to Motorcoaches

Since the present S.A.E. Standards for Bases, Sockets and Connectors were first criticized in 1922 as being unsatisfactory for motor-truck service, the Lighting Division Subcommittee on Bases, Sockets and Connectors has made a careful study of the needs of the automobile industry for lighting equipment. The information obtained during this time has shown conclusively that the present standards are satisfactory for passenger-car service, but that a stronger connector should be used for motor-truck and motorcoach service, on account of the severe vibration encountered.



TYPE OF SCREW CONNECTOR RECOMMENDED FOR MOTORCOACHES
The Severer Vibration Encountered in Motor-Truck and Motorcoach Operation Renders the Bayonet-Type Connector, Which Is Suitable for Passenger-Car Use, Unfit for These Classes of Service. Connectors of the Proposed Type Have Been Tested in Service with Satisfactory Results

As a result of considerable study, the Subdivision, of which C. E. Godley is chairman, proposed a screw-type of connector that was subsequently approved by the Lighting Division, with some minor revisions. The Division recommendation, which is given in the accompanying illustration, permits the use of three or four wires, the outside diameter being determined upon with such practice in mind. The type of connector proposed has been produced in the dimensions recommended and has stood up satisfactorily in service.

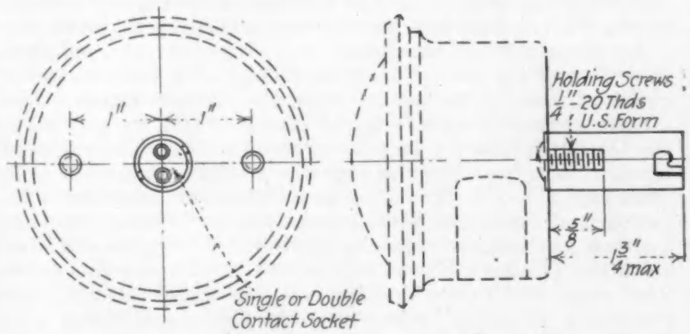
The recommendation was referred to the builders of motor-trucks and motorcoaches and only favorable comments were received from them.

The Subdivision on Bases, Sockets and Connectors is now developing a non-reversible double-contact type of connector to meet the requirements of manufacturers using two-filament lamps and to prevent the development of various sizes of this type of lamp varying unnecessarily in details.

TAIL-LAMP MOUNTING CHANGED

The Lighting Division has recommended that the present S.A.E. Recommended Practice for Tail-Lamp Mounting, p. B2 of the S.A.E. HANDBOOK, be revised to indicate that the window for illuminating the license-plate should be at the bottom, not at the right-hand side of the lamp.

The recommended practice revised as indicated is given in the accompanying illustration.

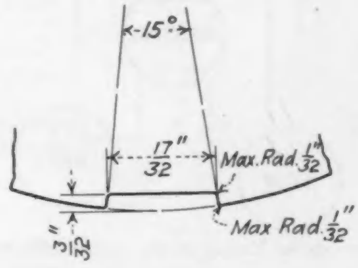


REVISED RECOMMENDED PRACTICE FOR TAIL-LAMP MOUNTING

LAMP GLASS DIAMETERS UNCHANGED

Present Standard for Notching Revised To Specify but One Notch

To determine the effectiveness of the present S.A.E. Standard for Head-Lamp Glasses, p. B3 of the S.A.E. HANDBOOK, a resurvey of general practice was made which indicated that the standard 8-5/32, 8½, 9 and 9½-in. outside diameters were used by only 32 of 72 passenger-car companies, or by about only 40 per cent. The notching dimensions specified in the standard were used by certain manufacturers in some details, but by no manufacturer in all details. It was felt that the standard had not been adopted more generally because of the individual requirements of the car builders, but information obtained in this connection showed that of 30 companies, 4 made it a policy to specify the glass dimensions, whereas 26 left this matter entirely to the lamp manufacturers.



S.A.E. NOTCH DIMENSIONS FOR HEAD-LAMP GLASSES

Following this resurvey, the Lighting Division recommended that the present standard be revised to specify a single notch at the bottom of the lamp glass instead of notches located on the horizontal and vertical center-lines, and that the head-lamps should be so constructed that the glass cannot be improperly installed, the head-lamp-glass diameters of 8 5/32, 8 1/2, 9 and 9 1/2 in. to remain unchanged. The notch dimensions retained as standard are as given in the accompanying illustration.

TWO FLEXIBLE-DISC SIZES ADDED

Number of Propeller-Shaft Flexible-Discs Increased from 21 to 23

The Parts and Fittings Division has recommended that the present S.A.E. Recommended Practice for Propeller-Shaft Flexible-Discs should be extended to include the 6 x ¼-in. and 7½ x ⅜-in. sizes, the latter to have ⅝-in. bolt-holes. These sizes are recommended owing to changes in practice that have taken place since the specifications were adopted originally in February, 1924.

The Division has also recommended that a definite tolerance of 0.010 in. be specified for the thickness of any one disc and that the title of the specification indicate that it covers non-metallic types of disc only. The detailed dimensions for the additional discs recommended are given in the accompanying table.

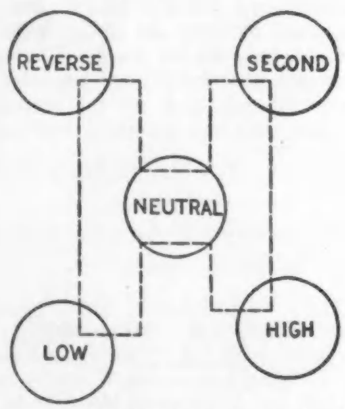
	Nominal Size	
	6 x ¼	7½ x ⅜
Outside Diameter, in.	6.000	7.500
Inside Diameter, in.	2¼	2¾
Bolt-Circle Diameter, in.	4⅝	5⅝
Number of Holes	6	6
Bolt-Hole Diameter, in.	½	⅝
Center-to-Center Hole Distance, in.	2-5/16	2-13/16
Thickness, in.	¼	⅜

REVERSE-POSITION LATCH CANCELLED

The present S.A.E. Standard for Three-Speed Gearshift Positions, printed on p. J2 of the S.A.E. HANDBOOK, specifies that "The reverse position shall be protected by a latch or its equivalent on motor trucks."

As it is understood that this provision is no longer necessary for three-speed transmissions, the Passenger-Car Division has recommended that it be cancelled, the S.A.E. Standard to be limited to indicating the positions of the gearshift lever as given in the accompanying illustration.

FRONT



S.A.E. STANDARD THREE-SPEED GEARSHIFT POSITIONS

PATCHING OF LEATHER APPROVED

The following clause has been approved by the Passenger-Car Body Division for inclusion in the specifications for Upholstery Leather now printed on p. L7 of the S.A.E. HANDBOOK:

> Not more than 15 per cent of the hides supplied may have up to five patches. The patches shall be equal to the rest of the hide in strength and flexibility, shall be invisible from the finished side and shall be waterproof. Weak or open veins and knife-cuts shall be reinforced and classed as patches.

At the 1925 Annual Meeting, the patching of grub-holes and other defects in upholstery leather was recommended by K. L. Herrmann, of the Studebaker Corporation of America, in a paper on automobile upholstery. It was stated at that time that patching methods had been developed which resulted in patches that were as strong and as flexible as the hide and that could not be detected from the finished side. The use of patched hides was not permitted by the leather specifications adopted at that meeting, however, as manufacturers were not equipped to patch leather in production, the patches being of temporary nature intended to prevent the coating from penetrating the hide. Since that time information has been obtained showing that leather is now being patched satisfactorily, a pyroxylin cement being used.

RADIATOR-COVER CLEARANCE SUGGESTED

The Passenger-Car Division has proposed for adoption as S.A.E. Recommended Practice that a dimension of 2½ in. be adopted as the minimum clearance between the radiator and the head-lamp tie-rod to permit the application of radiator covers when desired.

This recommendation is proposed as it is understood that the clearance allowed in many car designs is not sufficient to permit the use of radiator covers now on the market.

MOTORCOACH BATTERIES SIMPLIFIED

Seven Sizes Recommended by Storage-Battery Division for Future Practice

The present S.A.E. Standard for Storage-Batteries covers passenger-car and motor-truck batteries, but, owing to the special requirements of motorcoach service, is not satisfactory for the last-named service. The motorcoach industry, has, therefore, ordered batteries of such sizes and capacities as were considered desirable for the various operating requirements without regard to the existing production of the storage-battery manufacturers.

Recognizing the need for a definite guide, or standard, for the motorcoach builders, the Storage-Battery Division undertook during the summer of 1925 to draw up storage-battery specifications for motorcoach service. Information on current practice was obtained and at a special Division meeting held on Nov. 12 the data were reviewed and seven sizes of battery selected as meeting satisfactorily the present requirements of the motorcoach industry.

Although the capacities that have been specified for passenger-car and motor-truck batteries are based on the 20-hr. and 20-min. ratings, it is proposed to rate motorcoach batteries on the basis of the minimum current in amperes for 20 min. and the minimum capacity in ampere-hours at an 8-hr. rate. The 8-hr. period was selected on the assumption that an emergency requiring the entire lighting-load for more than 8 hr. would seldom arise and that the resulting current-rate, if based on a 3 or 5-hr. period, would be too high. The dimensions proposed are given hereinafter.

The ratings proposed were developed, subsequent to the Division meeting, by L. E. Lighton, of the Electric Storage Battery Co., he serving as a Subcommittee of one. The original battery dimensions were determined by a classification of batteries based on their capacity at the 5-amp. rate, information not being available at the meeting on the capacities based on the 8-hr. and 20-min. rates recommended by the Division.

As the capacities based on the last two ratings, owing to the effect of the plate thickness, changed the proper classification of some of the battery sizes, Mr. Lighton recommended certain changes in the original classifications as printed in the December issue of THE JOURNAL on p. 541. The principal changes were to lower the capacity of the first classification (Battery No. 21) from 118 to 108 amp-hr. for the 8-hr. rating and from 160 to 126 amp. for the 20-min. rate; to increase the original capacity proposed for the second classification (Battery No. 22) from 118 to 126 amp-hr. at the 8-hr. rate; and to combine the last two classifications (Batteries Nos. 26 and 27), the ratings for this classification to be 100 amp-hr. at the 8-hr. rate and 140 amp. at the 20-min. rate.

These revisions have been submitted to, but not finally approved by, the Storage-Battery Division and a supplemental report will therefore be submitted at the Standards Committee Meeting on Jan. 26.

Motorcoach Storage-Batteries

These specifications are intended to apply only to lead-acid storage-batteries for motorcoaches.

Ratings.—Batteries for combined starting and lighting service shall have two ratings. The first rating shall indicate the lighting ability and shall be the capacity in ampere-hours of the battery when it is discharged continuously at the 8-hr. rate to a final voltage of not less than 1.75 per cell, the temperature of the battery at the beginning of such discharge being 80 deg. fahr. The second rating shall indicate the starting ability and shall be the minimum current in amperes that the battery will deliver when discharged continuously at the 20-min. rate to a final voltage of not less than 1.5 per cell, the temperature of the battery at the beginning of such discharge being 80 deg. fahr.

MOTOR-COACH STORAGE-BATTERY DIMENSIONS

Battery No.	No. of Cells	Minimum Capacity at 20-Hr. Rate, Amp-Hr.	Minimum Current for 20 Min., Amp.	Maximum Over-All Dimensions, In. Length[1]	Width	Height
21	3[a]	108	126	17	7⅝	10¾
22	3[a]	126	147	19⅛	7⅝	10¾
23	3[a]	178	210	25⅞	7⅝	10¾
24	6[a]	88	105	26¾	7⅝	10¾
25	6[b]	88	105	20⅞	9⅝	10¾
26	6[a]	100	140	30⅞	7⅝	10¾

[a] Side-to-side assembly of cells.
[b] Double-row, end-to-end assembly of cells.
[1] The over-all end-to-end length includes handles, not hold-down devices. The handles and the hold-down devices shall be attached only to the ends of the case. Terminals and connections shall not extend above the handles; the latter shall be the highest point.

The existence of motorcoach storage-battery standards will make it possible for motorcoach engineers to design battery compartments of such size that, in case it is impossible to obtain batteries from the original source of supply, other makes of battery can be used without rebuilding the compartments or using undersized batteries.

The reduction to practice of the proposed motorcoach battery standards will be impossible without the active cooperation of the motorcoach builders. If they are not in favor of restricting their purchases to the sizes standardized, battery manufacturers can be found who will make non-standard sizes. On the other hand, motorcoach builders not entirely "sold" on the importance of standardizing motorcoach batteries can be influenced to abide by the standard sizes adopted, provided the battery manufacturers appreciate the importance of limiting production to only standard sizes and will explain matters clearly to such prospective purchasers.

MONOBLOC CONTAINERS REVISED

Partition Variation and Over-All Height Increased by Storage-Battery Division

At the November meeting of the Storage-Battery Division the meaning of the thickness variation specified for the partitions between compartments of monobloc containers conforming to the S.A.E. Recommended Practice, p. B24a of the S.A.E. Handbook, was questioned, the requirement in this respect reading, "The thickness of the partitions between compartments shall be 3/16 in. minimum and 1/4 in. maximum." As the thickness variation is intended, not as a tolerance for the thickness at any point in the partition, but as an allowance for the taper and, as it is desired to permit greater leeway for the amount of taper used, the Division recommends that this be revised to specify that "The thickness of the partition shall be not less than 3/16 in. at the top or more than 5/16 in. at the bottom."

Since the S.A.E. Recommended Practice for Monobloc Containers was adopted in March, 1923, an over-all width of 7⅜ in. has been adopted for storage-batteries. It is, therefore, recommended by the Division, in order to correlate these specifications, that the recommended practice for monobloc containers be revised to specify an over-all width of 7⅜ instead of 7½ in.

BATTERY INSTRUCTIONS CANCELLED

The present S.A.E. Storage-Battery Instructions, adopted in June, 1913, and printed on p. B25 of the S.A.E. Handbook, are, according to the Storage-Battery Division, no longer in accord with current practice. It is felt that these specifications, intended originally to serve as a basis for battery information in passenger-car instruction-books, no longer serve any useful purpose and the Storage-Battery Division recommends that they be cancelled.

BATTERY NOMENCLATURE EXTENDED

Electrolyte Included as Not Exceeding Specific Gravity of 1.300

The present nomenclature for storage-batteries, printed as Group 6, Section VIII of the S.A.E. Standard for Automobile Nomenclature, specifies but four storage-battery terms. As the Storage-Battery Division believes that a more complete battery nomenclature would be of value to car builders, service managers and others, the Division recommends that the following nomenclature supersede the present battery terminology.

Proposed Nomenclature of Automobile Batteries

- Storage-Battery
- Terminal Post
- Case:
  - Wood Case
  - Rubber Case (monobloc)
  - Composition Case (monobloc)
  - Tray (alkaline batteries only)
- Jar
- Cover
- Cell Connector
- Vent Plug (Filling Plug)
- Group:
  - Positive Group
  - Negative Group
- Plates:
  - Positive Plate
  - Negative Plate
- Post Strap:
  - Positive Strap
  - Negative Strap
- Separators:
  - Wood Separator
  - Rubber Separator
- Post Gasket
- Post Adaptor
- Sealing Nut
- Separator Hold-Down
- Battery Hold-Down
- Handles:
  - Plate Handles
  - Wire Handles
- Terminal Connectors:
  - Clamp-Lug Connectors
  - Taper-Thimble Connectors
  - Cable Connectors
- Through-Bolt
- Jar Spacer
- Sealing Compound
- Electrolyte (not exceeding 1.300 in specific gravity)

The recommendation is based on a report by G. W. Vinal, of the Bureau of Standards. The reason for including the term "electrolyte" is given as follows in Dr. Vinal's report:

> I have included the word "electrolyte," specifying that it is not to exceed 1.300 specific gravity. In the strict sense of the word, electrolyte, as used by the

physical chemists, means the sulphuric acid. In common parlance, however, the word electrolyte is taken to mean the solution within the battery cell. Some battery and acid manufacturers have used the word electrolyte to mean a solution of sulphuric acid having a specific gravity of about 1.400. This can hardly be accepted as correct use of the word. It fulfills neither the definition of the physical chemist nor the commonly accepted meaning of the word as applied to eletrolytic cells, including batteries and other types.

Still another objection to the use of the word electrolyte as applying to a solution of 1.400 specific gravity arises in the advertising of a number of so-called patent solutions for storage-batteries. It is claimed for some of these that they are milder than the usual battery electrolyte. Many of them contain about the same percentage of sulphuric acid as is used ordinarily in a battery, but the misuse of the word electrolyte may afford some possible ground for their claim.

BALL-HANDLE THREADS RECOMMENDED

Two Threads Recommended in Place of 11 Threads Now Used by Industry

The S.A.E. Standard for Control-Lever Ball-Handle Inserts was drawn up by the Transmission Division and approved by the Society in 1920. Information submitted some time ago indicated that this standard had never been adopted by the industry and a survey was therefore made.

The summary indicates that 11 threads are used by the various car-builders and that only 5 out of 36 companies are using the thread published by the Society as "Standard." The threads used, together with the number of car builders using the threads, are as follows:

Thread	Number of Users
1/8 Pipe	1
1/4 Pipe	4
5/16-24	1
3/8-16	2
3/8-24	11
7/16-18	1
7/16-20	2
1/2-13	4
1/2-20 (S.A.E. Standard)	5
1/2-20 External	1
5/8-18	4
	36

As it is appreciated that the purpose of the present standard is to obtain only interchangeability of the ball-handles and control-levers, the Transmission Division has recommended that all dimensions be omitted except the ½-in.-20 ball-handle thread, which shall be specified for motor-truck applications, and a ⅜-in.-24 thread specified for passenger-car applications, the thread length of both to be ⅝ in.

POWER TAKE-OFF TO BE STANDARD

The S.A.E. Recommended Practice for Power Take-Off specifies that for all general installation of power-take-off drives in motor trucks the pad and gear locations for the transmission tire-pump mounting shown on p. E1 of the S.A.E. HANDBOOK shall be used.

This recommendation was adopted in August, 1919, and since that time has been generally adopted by the industry. The Truck Division therefore proposes that this recommended practice be recognized as an S.A.E. Standard.

PROPELLER-SHAFT PRACTICE CANCELLED

In March, 1922, the present S.A.E. Recommended Practice for three-joint propeller-shaft midship mountings was adopted by the Society, this being based upon the recommendation of the Truck Division. Since the adoption of this specification the number of three-joint propeller-shaft midship mountings has increased steadily, the number made by one manufacturer showing an increase of 98 during 1923 and 1924, and the total number of designs made in 1924 being 234.

Recognizing that it is extremely desirable that standard practice be developed for this important unit, a Subdivision has been recently appointed to review present practice and to develop specifications that will be generally adopted. As the present specifications have not been adopted in general practice, the Truck Division recommends that they be cancelled in order that future work of the Subdivision shall not be embarrassed by the existence of discredited specifications.

FRAME STANDARD REVISED

The Truck Division has recommended that the present S.A.E. Recommended Practice for Motor-Truck Frames, p. H21 of the S.A.E. HANDBOOK, be revised by the omission of the nominal and actual side-rail depths, limiting the specification to the frame widths only. The specification, revised as proposed, is given in the accompanying table.

REVISED DIMENSIONS FOR MOTOR-TRUCK FRAMES

Truck Capacity, Tons	Frame Width, In.		
	Straight Frames	Offset Frames	
		Front	Rear
Speed Wagons	32	....	....
¾ to 1½	34	31	34
2 to 2½	34	31	34
3 to 3½	38	....	....
Over 3½	38	....	....

DECEMBER COUNCIL MEETING

A MEETING of the Council was held in Detroit on Dec. 16, those present being President Horning, Past-President Crane, Vice-Presidents Lítle and Scott, Councilors Brumbaugh, Burkhardt, Hunt and Rumney, and J. F. Winchester and Arthur Nutt nominated to serve as councilors during 1926. Fifty applications for membership were approved. The resignations of 16 members were accepted, and 4 members were dropped for non-payment of dues that accrued Oct. 1, 1924. Eight reinstatements to membership were made; also seven transfers in grade of membership.

The financial statement as of Oct. 31 showed a net balance of assets over liabilities of $162,467.64, this being $4,221.03 more than the corresponding figure on the same day of 1924. The net revenue for the month of October was $20,156.94, the operating expense during the same time being $19,047.99.

The following members were named to serve during 1926 as the Ordnance Advisory Committee of the Society: W. G. Wall, chairman; H. W. Alden, B. B. Bachman, W. L. Batt, A. W. S. Herrington, A. F. Masury, C. M. Manly, P. E. Holt and Dent Parrett. This Committee will meet in conference with Ordnance Department officers and associates at the offices of the Society in New York City during the 1926 Automobile Show Week there.

Various other matters discussed and acted upon by the council, relating to meetings, membership, the Sections, and Standards and Research Departments, are mentioned elsewhere in this issue of THE JOURNAL, or will be reported upon at the 1926 Annual Meeting of the Society.

AUTOMOTIVE RESEARCH

The Society's activities as well as research matters of general interest are presented in this section

THE STATUS OF HEADLIGHTS

Plans To Improve Unsatisfactory Night-Driving Conditions Briefly Stated

The Society's Research Sub-Committee on Headlighting met on Dec. 8 for a general discussion of the headlight problem. A number of guests representing car and lamp manufacturers and State authorities, who were invited to present their views, were also present at this meeting.

The principal reason for calling this meeting was the fact that in spite of the existence of certain specifications for head-lamps and also of various attempts to enforce these specifications, driving at night is still very unsatisfactory because of imperfect illumination. In turn, this unsatisfactory condition has prompted various States to formulate and enforce regulations that it was thought would constitute suitable means for increasing safety. These efforts on the part of State motor-vehicle administrators no doubt were prompted by statistics of accidents. Moreover, a general desire on the part of motorists for improved night-driving conditions has been expressed.

The ramifications of the problem are such that close cooperation between car and lamp manufacturers and State authorities seems imperative, even if for no other purpose than to have the problem stated as comprehensively as possible so that from the various suggestions made a research program can be formulated. In this connection it will also be of interest that the Committee on Motor Vehicles of the National Conference on Street and Highway Safety has expressed the need for a study of proper road illumination. An endeavor to minimize undesirable glare should also be given immediate consideration. A Tentative American Standard for laboratory approval of headlighting devices is now in existence. This is based on well-known specifications. While these specifications may represent the best compromise of the conflicting requirements that are to be met by good head-lamps, it must be borne in mind that the art is advancing continually and new knowledge and devices are being put forward from day to day.

Moreover, it is well known that since the present regulations were adopted changes in the construction and in the use of motor vehicles have taken place which accentuate all the shortcomings inherent in beam control. The lamp level that was specified years ago has remained fixed, while due to changes in car design the plane taken through the driver's eyes has been lowered. This has greatly reduced the margin of safety against having high candlepower beams projected into the approaching driver's eyes. Other factors influencing this margin of safety against glare that have become prominent since the present regulations were adopted are:

(1) The number of deteriorated lamps of bad construction and in poor adjustment has greatly increased with the increasing number of used cars. Enforcement officers must have a difficult problem to check up on the multitude of cars in service. We know that some lamps, when properly set one day may be out of adjustment the next

(2) Springs of greater flexibility and balloon tires are being used, causing on slight overload or upon settling of the springs or during periods of bobbing, an upward projection of high candlepower beams

(3) Traffic has increased on all roads

(4) Roads have been improved so that all cars can maintain a higher driving speed

(5) The tendency on the part of the public to demand such illumination from approaching cars as will minimize glare is growing

Further, in the interest of safety, the tendency on the part of State administrators has been to demand greater candlepower. The motorists who are frequently forced to look into bad headlights with the beam directed too high have met the situation by demanding still further increase of their lights, so that an offensive competition for brighter lights has resulted. If, on the other hand, brighter lights are directed too low, an area is created in front of the car that is much brighter than the areas farther ahead and at the side that must be seen.

From this it follows that the existing conditions seem to militate against regulations that permit very high candlepower and provide as a safeguard against glare a rather complicated control of high candlepower beams. Because of the conflicting requirements that are expected from head-lamps the inducements to ignore some phases are obvious. Other factors are suffering in effectiveness because of the necessarily delicate features of some head-lamp parts. This makes it necessary that manufacturers and dealers educate car-owners on the rudiments of illumination. Car-owners should be instructed on the functions of head-lamps in language that they understand.

In Government laboratories, universities and technical colleges, scientific men have been concentrating on problems of vision that may prove to be directly applicable to our headlight problem. Car builders should realize that the problem is urgent and that drastic legislative action may be impending. Every effort singly and collectively should be made to determine and eliminate weaknesses after they have been recognized and proved to impede the best results. Coordination of research and a thorough understanding of the problem from every angle must ultimately be of benefit to all.

Coordinated efforts in the solution of the headlamp problem would tend toward the proper condition, namely, that the industry regulate itself rather than let a bad condition persist until law enactments are forced upon innocent victims. Moreover, through sporadic law enactments the industry cannot benefit. This is brought out very forcefully by the proposal in one state where enforcement officers are discussing voltage control as one solution of the problem. Voltage control is well known to be an intricate problem for automotive engineers. Suffice it to say that railroad engineers with much larger and heavier equipment have not solved the problem satisfactorily.

From what has been said it will be gathered that many important reasons why a re-survey of the headlight problem should be undertaken can be offered.

Last, but not least, another very important factor should be mentioned, namely, that in the past car builders have been inclined to leave to the discretion of the lamp manufacturer the design and construction of head-lamps. Car builders have been largely satisfied with the assurance of the lamp manufacturer that the illumination from the equipment provided would comply with all requirements.

After the session of the above-mentioned Research Sub-Committee, a joint meeting was held with the Committee on Motor Vehicle Headlighting of the Illuminating Engineering Society. At this meeting the following important resolution was passed unanimously:

A Joint Steering Committee of the Illuminating En-

gineering Society and the Society of Automotive Engineers should be named by the officers of the two Societies to take charge of a program of headlight research, this Joint Steering Committee to determine what the program should be, and how it should be carried out, by whom and where.

The indications are that this Committee will be constituted of 12 members, equally representing the two Societies. A Sectional Committee will be organized at an early date under the procedure of the American Engineering Standards Committee to make recommendations pertaining to motor-vehicle lighting. This Sectional Committee will be supplied with facts based on researches. The sponsors of the Sectional Committee are the Illuminating Engineering Society and this Society. Thus, a beginning has been made for a comprehensive campaign on the headlight problem. It is hoped that, in view of the efforts so far made, wholehearted interest and support will be forthcoming from all concerned.

MEETINGS OF THE SOCIETY

(*Continued from p.* 14)

grinding and traced the steps that led to the adoption of the method of lapping at present in use. In finishing the cylinder-blocks, two boring and one reaming operation bring the bore to within from 0.015 to 0.018 in. of the final size. The size-reaming operation is performed on a single-spindle machine so that all the holes in the same block will be of uniform size. Important points in obtaining a correctly reamed bore are the grinding of the reamer and its hardness. Blades of 77-82 scleroscope-hardness are used. For the final finishing or lapping 0.0015 in. is left.

Lapping is performed on a single-spindle machine having a speed of 400 r.p.m. and a hand feed, although machine feed is considered preferable and probably will soon be substituted. In the last 2 years, several varieties of lap have been tried, but that now in use is made by the Hutto Company and is of the six-stone type embodying a double three-point-contact support for the stone that makes the grinding element self-aligning as well as self-centering. These features are due to the fact that the two adjusting-cones and stone-holder pins that rest upon them have a limited freedom in which to float until the cutting-surfaces of the stones are all parallel. This floating of the adjusting-mechanism also compensates for any unevenness of wear of the stones because of lack of uniformity in their composition. A six-cylinder block can be reamed in 5.6 min. and lapped in 9.0 min., a total of 14.6 min. Grinding a cylinder-block of the same size required 54 min. Mr. Fors believes that lapping produces a better and more accurate cylinder bore than does grinding, and that the labor cost is less.

Honing Used at Oakland and Dodge

H. C. Miller, of the Oakland Motor Car Co., stated that the difficulty his firm had encountered because of the bell-mouthing of the bore at the top had been overcome by placing a scrap block above the cylinder being honed; this prevents the hones from flying out. Another difficulty, caused by the laps' wearing and the slots' becoming larger, and the consequent backing-up of the stones against one side, was turned into an advantage. The stones are turned round as soon as they get half-way to a full round surface and a narrow cutting-edge is produced.

A novelty, insofar as other methods that have been described are concerned, was described by George Babcock, of Dodge Bros. Having faced the problem during the war of making French recuperators, which required that two holes be finished smooth and true with less than 0.001-in. tolerance in the bore of the hole, which was from 3 to 5 in. in diameter and 7 ft. in length, Dodge cylinders are still honed with exactly the same hones that were used in making the recuperators; and the hones are not rotated but, so far as possible, are merely reciprocated.

The holes are finished, so far as the mechanical problems are concerned, in a manner similar to that described by others but, as the perfection of the reamed hole is considered the important feature, a special type of reamer is used.

In the lapping or honing, the stone, instead of being one small stone rotating at high speed, is composed of three pieces backed with a steel blade and the separating lines at the head are comparatively narrow. So far as possible, the whole bore is covered with stone, and the reciprocation is without rotation. The grade of the stone is very important. The honing of the cylinder is carried to a point at which barely a trace of the reamer marks is left and the finishing is done by grinding.

Grinding Satisfies Lincoln and Paige-Detroit

According to O. H. Hovey, of the Lincoln Division of the Ford Company, the cylinder bores of Lincoln cars are still ground. The blocks have a Brinell hardness reading of 225. Boring requires three operations and from 0.004 to 0.006 in. is left for grinding. The blocks are reciprocated several times before they are brought to size. Nothing is left for honing, and during the honing the block is reciprocated by a straight up-and-down movement for about 125 strokes.

The hone is of special design, similar to that used at the Dodge plant. After beginning to hone, conditions were disclosed that led to still greater care being taken with the grinding. Each grinding operator stamps the cylinder-block after the grinding operation and, if any unusual conditions are disclosed by honing, that grinding machine is shut down and a check is made.

After honing five or six cylinders of such hard material, the stone becomes glazed but the glaze is removed by a rough Ford cylinder that is sent through the machine and reciprocated for possibly 30 sec.

Another condition that caused honing to be begun by the Lincoln organization is that the piston, which is composed of aluminum alloy having a Brinell hardness of 160, is somewhat softer than that used previously, and it was not desired that it should be used for lapping.

After describing the various operations pertaining to the finishing of the cylinder bores of Paige-Detroit engines, V. Colliau remarked that with grinding machines in good condition and properly set up, bores will be ground uniformly square and they will usually be more accurate than when honed and reamed; otherwise, the reamed and honed bore should be more accurate. It is common practice, he said, to hone both ground and reamed bores to obtain the most desirable finish. When the grinding and reaming marks have been removed by honing it is impossible to distinguish between the two methods. Having been successful in reaming holes straight and round within a limit of 0.0005 in., Mr. Colliau stated that he had not been able to secure so great accuracy on a production basis by grinding, and that he preferred reaming to grinding, therefore, when a 100-per cent honed finish is required. The floor space required for reaming and honing is much less than for grinding; and the investment in equipment and the cost of labor and up-keep are lower.

After reaming and honing for several months the Paige-Detroit Company reverted to grinding. By using all the equipment that had been installed for reaming and honing the company was able to ream to within 0.004 in. of the finished size and to grind off this amount of stock. The cost of the grinding operation had been reduced from 60 to 40 cents per block. Then by adding two unskilled operators to do the reaming and honing operations at a cost of 15 cents per block, the grinding operation was eliminated and the labor cost was reduced 25 cents per block.

(*Continued on p.* 40)

Vol. XVIII January, 1926 No. 1

Automotive Proving Grounds of the General Motors Corporation

By O. T. KREUSSER[1]

DETROIT SECTION PAPER *Illustrated with* PHOTOGRAPHS

ABSTRACT

LAYOUT, facilities and activities relating to making road-tests of motor vehicles at the 1125-acre proving grounds of the General Motors Corporation near Detroit, this tract being designed to provide a place where road conditions are suitable for obtaining data that can be interpreted accurately, compared with similar data and used constructively, are outlined and illustrated. Adequate facilities are provided and ideal road-conditions have been established so that motor-vehicle tests involving endurance, speed, acceleration, hill climbing, riding-quality and other comparative tests can be made. Conditions are such that tests can be repeated from day to day, thus compensating for the variations of the weather and other factors. Complete and conclusive tests can be carried out readily and promptly, and the results are free from guesses and personal opinions.

The speed track is 20 ft. wide and nearly 4 miles long. Traffic is in one direction, clockwise. The turns are banked and can be driven over safely at a speed of 65 m.p.h., the high-speed cars passing the slower traffic by using the well-banked part of the roadbed.

The 1⅝-mile concrete straightaway course runs east and west and is equipped with graveled loops at each end so that runs can be continued in either direction without gearshifting or stopping; all tests are run in both directions and then averaged to cancel out the effects of wind. It is over this course that acceleration; deceleration; rolling-friction; riding-quality; fuel-economy at fixed speed, minimum-speed and maximum-speed; and similar tests are carried out. Another interesting facility is the concrete under-water roadway, which is 200 ft. long with 100 ft. of level section 12 ft. wide equipped with parapets to permit flooding to a depth as great as 2 ft. Special tests can be made here by driving vehicles through varied depths of water.

Three test hills having continuous accurate gradients furnish means for measuring, comparatively, engine powers under driving conditions. An endurance-test route winds through one portion and connects the test hills with the speed loop; gradients as high as 24 per cent are included.

The proving-grounds activities include the carrying on of endurance tests and experimental-car operation by each division of the Corporation and the comparative engineering and endurance tests of such cars in current production as may be of interest. The various tests made are enumerated, and many details of the methods of test procedure are stated, together with descriptions of the testing equipment.

CONDITIONS on the public highways are far from ideal, or even adequate for running the type of test the automotive engineer requires for developing and proving his designs, and the purpose of the proving grounds is to provide a place where road conditions and road discipline can be controlled so as to provide motor-vehicle-test data that can be interpreted, compared and used constructively. Here, on private property more than 1125 acres in extent, facilities are provided and road conditions ideally suited to conduct motor-vehicle tests involving endurance, speed, acceleration, hill climbing, braking and riding-qualities, and many other comparative tests. Conditions are such that tests can be duplicated from day to day, thus compensating for the variations of the wind, the weather and other factors. Where one can control traffic conditions and avoid the many discouraging interferences met with on the public highways, besides being able to make

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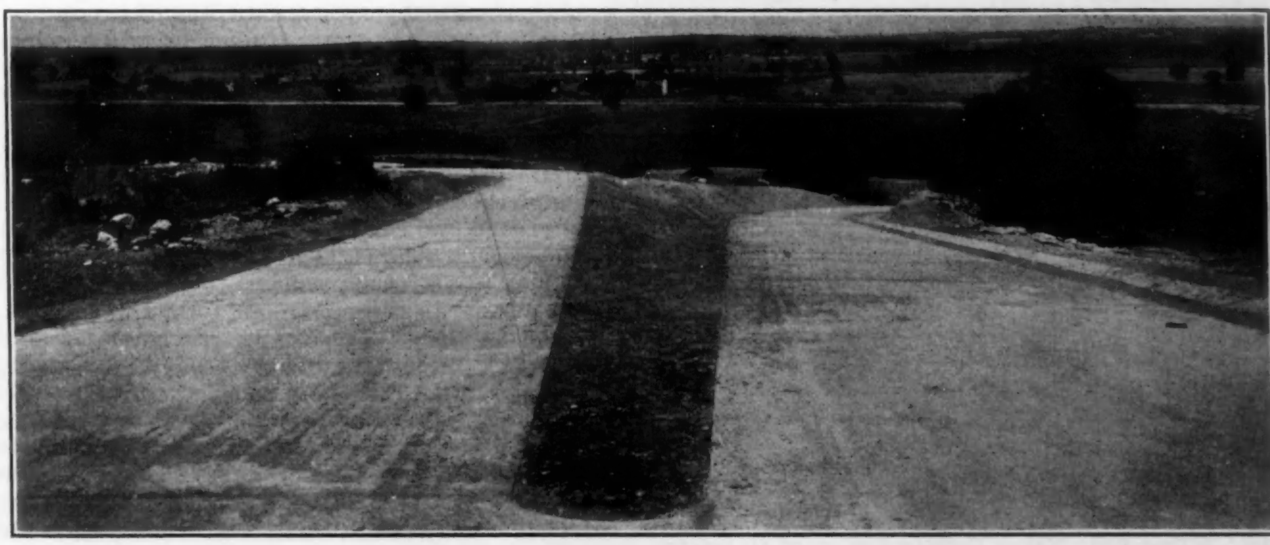

FIG. 1—THE PROVING GROUNDS OF THE GENERAL MOTORS CORPORATION
All the Property Shown Is Included. The View Illustrates Two Well-Graded Turns and the Straightaway Track Is Seen in the Distance

changes, adjustments and repairs conveniently and speedily, complete and conclusive tests can be conducted promptly and easily and the results are free from guesses and opinions.

The proving grounds are located conveniently within easy driving distance from any of the General Motors' car plants and engineering departments. They occupy one of the few localities in southern Michigan where a flat valley suitable for speed-track work is adjacent to a hill section rising more than 250 ft. above the lowland and providing a suitable range for hill roads and endurance-testing work, as indicated in Fig. 1. Hilly land suitable for test roads was found by looking over the sections that the railroad builders detoured, which accounts for the proving grounds being 4½ miles from the nearest railroad with little probability of ever building a useful railroad-spur because of the heavy grades; so, all materials and supplies must be hauled by motor truck. The hill land is entirely of glacial-moraine formation; it consists of gravel, sand and boulders. Many boulders that weighed tons were found in the projected new roads. Although gravel is available and is the first material we turn to in our road building, it costs considerably more than one expects to build a gravel road, even with gravel so abundant and close at hand, because much unsuitable and waste material must be handled for every cubic yard of material suitable for placement on the road.

Testing Courses

The speed track is located in the valley part of the proving grounds, which is 980 ft. above sea level. It is 20 ft. wide and is almost 4 miles long. At present, nearly all is Tarvia roadbed, with a new section of gravel that we hope to treat with Tarvia as soon as is practicable. This road is used when making car-test mileage of all descriptions. Traffic is in one direction, clockwise. The turns are banked or superelevated, as shown in Fig. 2, and a car can be driven around them at a speed of 65 m.p.h., safely, the high-speed cars passing slower traffic by taking the higher or well-banked part of the roadbed.

The concrete straightaway shown in Fig. 3 is about 1⅜ miles long and also is located in the valley. It is one of the few pieces of roadway actually designed and built to be perfectly straight and perfectly level. The

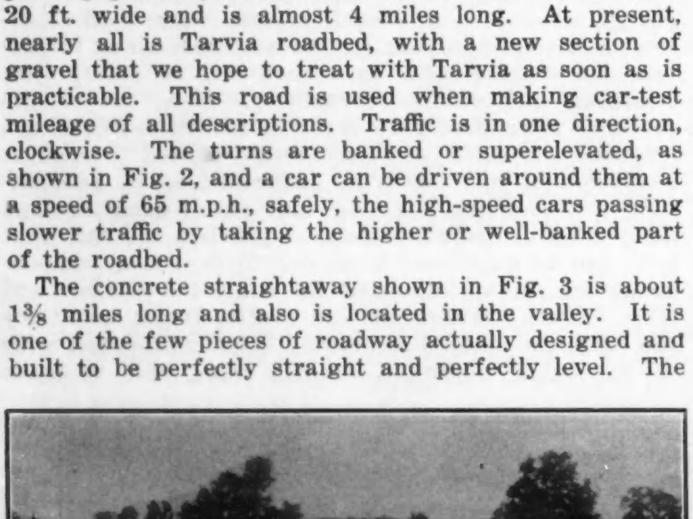

Fig. 2—The Speed Track
This Road Is Used When Making Car-Test Mileage of All Descriptions. Traffic Is in One Direction, Clockwise, the Turns Are Banked and a Car Can Be Driven around Them at a Speed of 65 M.P.H., Safely, the High-Speed Cars Passing the Slower Traffic by Taking the Higher or Well-Banked Part of the Roadbed

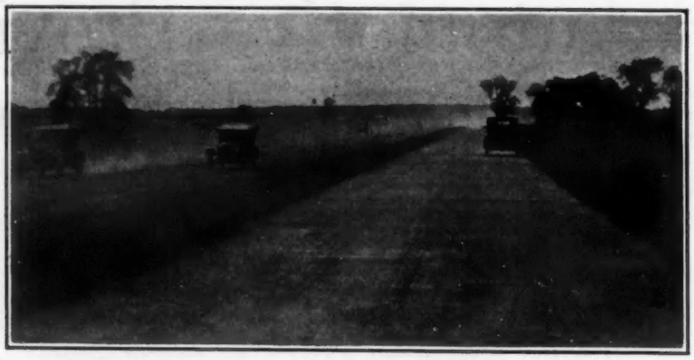

Fig. 3—The Concreted Straightaway
It Is About 1⅜ Miles in Length and Is One of the Few Pieces of Roadway Actually Designed and Built To Be Perfectly Straight and Level. Graveled Road-Loops at Each End Are Provided for Continuing Car Runs in Either Direction without Gearshifting or Stopping. It is Used Exclusively for Engineering Tests

road runs east and west and is equipped with graveled road-loops at each end for continuing car runs in both directions without gearshifting or stopping. The straightaway is one of the most useful parts of the proving-grounds facilities from the engineer's standpoint. It is used exclusively for engineering tests. All tests made on it are run in both directions and averaged to cancel out the effects of wind. Acceleration; deceleration; rolling-friction; smooth road-riding qualities; fuel economy at fixed, at minimum and at maximum speeds; and similar tests are made on this road. Here, wind is the variable factor that might prevent consistency of tests, but proper observations of the weather enable suitable weather to be chosen without great inconvenience. As a general rule we do not record tests in which the maximum speed east and the maximum speed west differ by more than 3 m.p.h. Many tests are made in which no difference appears between the runs east and those west.

Adjacent to the east end of the straightaway, a concrete under-water road 200 ft. long, comprising 100 ft. of level section 12 ft. wide that has parapets to permit flooding from barely wetting to as deep as 2 ft., is being installed. This special road is of interest in connection with determining how wet one's feet become in many of the closed cars as they are driven along a puddled road. The road will also be used to put brakes in condition for deceleration tests under simulated rainy-day conditions. Further, a standard way of determining the amount of mud and water thrown up on the windshield and the body due to wheel-wash will be of interest.

Concrete Test-Hill Roads

Three concrete-roadbed test-hills having continuous accurate grades furnish means to measure power under driving conditions comparatively. Each hill starts from level ground and curves into gradients of 7.20, 9.92 and 11.60 per cent. The 11.60-per cent grade shown in Fig. 4 and the 9.92-per cent gradients, together with the vertical curves and the level stretch, form a 20-ft. road more than 2800 ft. long. The 7.20-per cent grade, also a 20-ft. road, has a Y-connection with the 11.60-per cent grade and is more than 1250 ft. long. These hills are used for hill-climbing tests, in which the cars pass the starting posts at different speeds and are checked against time and distance traveled, when the cars operate under standard load and test conditions. Wind, temperature and barometer conditions must be watched and corrected for to assure consistent results if checking over a period of time.

Most of the testing done on the test hills usually is

directly comparative work, in which weather variables do not affect the results. Up to the present, the test hills have been two-way roads. The completion of the adjacent roads now being finished will permit using the concrete-roadway hills for up-hill tests only, going down hill over the new roads. In each instance, a complete closed road-loop will be connected with each concreted test-hill.

An endurance-test route called the hill road winds through the southern portion of the property as indicated in Fig. 5. This road continues from the concreted hill-roads and eventually leads into the speed loop. It has up and down grades including gradients as steep as 24 per cent. At present, the permanent organization controlling the proving grounds comprises 50 people. It is headed by the director, who is responsible to the general technical committee of the General Motors Corporation and its sub-committee.

FIG. 4—SCENE ON ONE OF THE GRADE-TEST HILLS
The Roadway Is Designed So As To Have a Constant Accurate Spiral Gradient of 11.6 Per Cent from the Bottom to the Top of the Hill

PROVING-GROUNDS ACTIVITIES

The regular activities at the proving grounds include the carrying on of endurance tests and experimental-car operation by each motor-car and truck division of the General Motors Corporation. All permanent facilities and equipment of the proving grounds are available for such operation; so, everyone concerned with making tests uses similar procedure and similar means for measuring results. The proving-grounds organization is responsible for the maintenance of property and of roads and for continuous accuracy and proper use of the test equipment. The other regular line of activity of the proving grounds comprises the comparative engineering and endurance tests of such current-production cars as may be of interest. To give some idea of the extent to which the analytical endurance-tests of the cars are carried, the car-mileage made on the proving-grounds roads alone runs well over 200,000 miles per month and is steadily increasing.

In gathering the comparative data pertaining to different cars, the proving-grounds activities are concentrated to provide constructive information as reflected from the customer's point of view. As an example, if two cars provide an equal amount of leg room and seating comfort and one car can be steered in a circle of 10 per cent less diameter than the other one, it can be deduced that the one having the shorter steering-radius has an advantage from the customer's point of view, assuming everything else equal. As another instance, if the driver in one car has a vision through the windshield and past the corner posts that is 20 per cent greater than is possible in some other car, the one providing the greater area of vision has an advantage if everything else is equal. Unfortunately, but of necessity, the automobile must be a compromise that involves many factors, and any one of these factors may be of major importance to a particular customer or to a prospect. The car mentioned as having a shorter turning-radius may be less steady to drive on rough roads, and the car having greater driver-vision may not have a desirable rakish appearance or the corner posts may be too flimsy and fail to provide a rugged door-hinge hanging that is satisfactory from a durability standpoint. However, by dissecting the car into those features that made up a desirable product from the customer's standpoint, many interesting comparisons can be made that help to provide better cars from the average customer's point of view. In the final analysis it is this point of view, multiplied many fold, that the commercially successful car of today and tomorrow must meet with good measure.

STANDARD TEST-PROGRAM

We purchase a car from a General Motors division in the regular way. So far as possible, we limit our present tests on passenger cars to closed models having standard equipment as furnished by the manufacturer. In most cases we obtain five-passenger cars which we load arbitrarily with a passenger and a sand load totaling 450 lb. This is our standard test-load and is carried on all the tests we make on the cars. The load is placed on the seat cushions. Upon receipt of the car we inspect it thoroughly and make a detailed record of assembly shortcomings, weight, dimensions, quality of finish, and of the many different angles of engineering specifications. The car is operated first at speeds not over 25 m.p.h. Speed is increased gradually as the car limbers-up and, after 2000 miles of operation, it is tuned-up for continued full-load and maximum-speed running. If the general "feel" of the car at this time indicates that it is still somewhat stiff, additional mileage is run until any possible damage due to friction overload is minimized. Particular care is taken not to permit any operation that will possibly detract from the best possible performance of the car later.

FIG. 5—THE HILL ROAD
An Endurance-Test Route Called the Hill Road Winds through the Southern Portion of the Property. It Includes Gradients As High As 24 Per Cent

FIG. 6—FIFTH-WHEEL ELECTRICALLY CONTROLLED SPEEDOMETER
All Measurements of Speed Are Made Either by This Apparatus or Are Calculated from Elapsed Time over a Measured Distance on the Straightaway Course as Determined from Stop-Watches

Upon completing 2000 miles the car is gone over very completely, tightened-up and adjusted; carbon is cleaned out; valves are reground; and the bearings are examined for proper clearance. The lubrication is checked, the brakes are examined for dragging effect and all details which, from experience, we have learned may detract from obtaining the best possible performance, are inspected. The car is then tuned-up to provide maximum-power with consistent economy. If any doubt exists as to performance on the tune-up, the car is taken to an authorized or factory service-station for a confirmation check-up. The car is then ready for the 2000-mile engineering-tests. So far as possible, a group of different cars in the same competitive class are brought through for simultaneous tests.

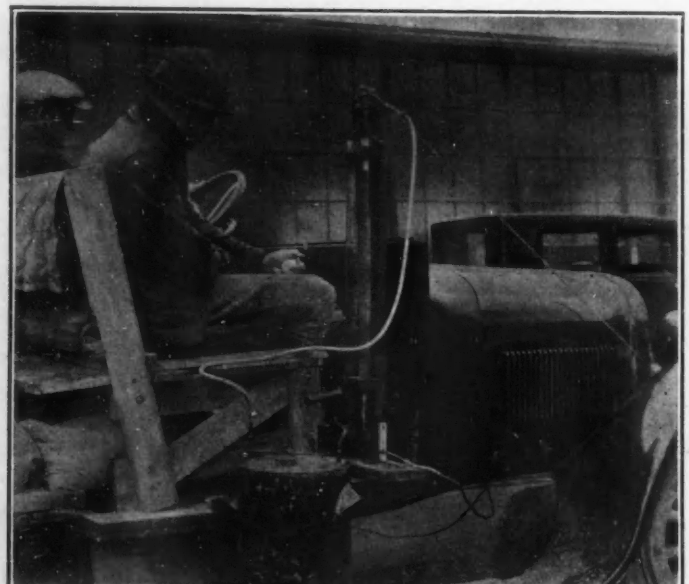

FIG. 7—FUEL CONSUMPTION MEASUREMENT
For Obtaining Measurements of Fuel Consumption, Glass Burettes Having 0.5-Cc. Gradations Are Used As Shown

ENGINEERING TESTS, PROCEDURE AND EQUIPMENT

The engineering tests comprise those for

Minimum Speed
Maximum Speed
Hill Climbing
Acceleration
Deceleration
Economy Runs at Different Constant Speeds
Vibration
Noise
Riding-Comfort
Brake
Clutch Pedal
Steering Effort and the Like

Standard conditions are established for each set of tests, regarding temperature, load and the like, and these are outlined so as to minimize the variables that may affect results.

One great problem in developing ways of analyzing the many features and functions of a motor car consistently is to develop means to make the necessary measurements impartially and keep them free from human prejudice and opinion. This largely narrows down to developing and making new measuring and indicating instruments. We are fortunate in work of this sort in having available the General Motors Research Laboratories at Detroit to help in this important phase of the work.

All measurements of speed are made either by a fifth-wheel speedometer or over measured distance on the straightaway against time. We have found the fifth-wheel speedometer shown in Fig. 6 a very convenient, accurate and reasonably rugged instrument. Stop-watches that are frequently checked and adjusted for accuracy are used in making time measurements. One man in the organization is responsible for checking the time pieces for accuracy and keeping them in condition.

For obtaining measurements of fuel consumption, glass burettes, having 0.5-cc. gradations, are used for measuring fuel-economy runs as indicated in Fig. 7. While this method of measuring fuel is subject to slight temperature-variations, for practical tests we find the scheme of volume measurement, by using two burettes with a three-way cock, desirable in preference to any weighing method. Regular economy-runs are made, beginning at 10 m.p.h. and increasing at 5-m.p.h. intervals to maximum speed, on the concrete level straightaway, running 0.8 miles against time in each direction.

ACCELERATION AND DECELERATION

Our present accelerometer causes electric sparks to puncture holes in a narrow strip of paper, thus producing a space-time record which, by graphical differentiation, is converted into a speed-acceleration record. Three rows of holes are punctured in the paper; one row of holes records car movement at 1-ft. intervals, and the second row at 10-ft. intervals. The third row of holes records time at ½-sec. intervals. The paper is moved at constant speed by a speed-governed electric-motor driven by a 12-volt battery. The car-movement recording-mechanism is actuated by a fifth wheel clamped to the running-board, as shown in Fig. 8, with pulley ratio and internal gearing designed so that a cam operates an ignition-breaker mechanism every 1 ft. and another cam operates it every 10 ft. of the rolling circumference of the fifth wheel. Due to the low inertia of the fifth wheel, no measurable slip exists between distance traveled and distance recorded.

The brake decelerometer comprises in one instrument the means for measuring and recording foot-pedal pres-

sure and deceleration in feet per second per second. The decelerometer element is of the James type and consists of a weight mounted on top of a stiff vertical-spring. The movement of the weight is carried to an arm and a pen, causing the latter to move across a paper strip that is driven by an electric motor as is indicated in Fig. 9. Pressure is measured by a flattened tube-element that carries a pen arm, pressure being transmitted to this element through a copper tube connected with a diaphragm mounted on the brake pedal. A liquid is the pressure-transmitting medium.

The amount of steering effort is obtained by a duplicate steering-wheel device that clamps to the regular steering-wheel of the car and transmits effort through calibrated-spring plungers arranged with sliding riders that indicate maximum pressure in either direction, as illustrated in Fig. 10. These pressures are corrected for particular wheel-diameters. Clutch pedal-pressures are measured by a simple yoke device shown in Fig. 11, using a spring balance that carries a maximum-pressure rider so that pressure can be applied under standard operating-conditions and readings taken from the instrument after the car is brought to a stop.

Reflection tests are made by locating the driver in the car in a normal driving-position over the center of a 100-ft.-diameter circle that is staked off in indicated degrees, closing the windows and carrying a light around the circumference of the circle. The degrees of the angles at which the reflection shows-up on the glass in the driver's compartment are recorded.

For vision tests, the car is driven in front of a wall that is cross-sectioned by chalk lines and, with the driver's eyes in a fixed position, he marks on cross-section paper the obstructions and limiting boundaries that interfere with a full view of the cross-sectioned wall. Vision is divided into two components, vision above and vision below a horizon line on a level with the driver's eyes.

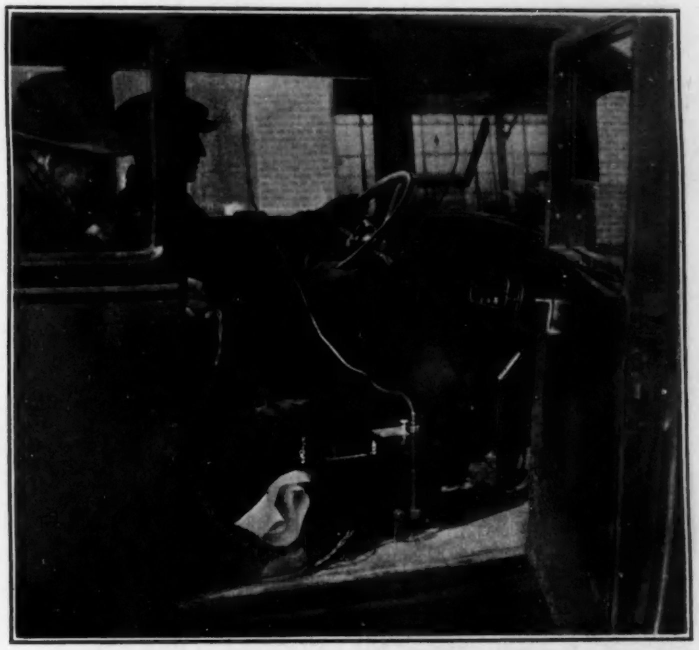

Fig. 9—Recording Brake-Testing Decelerometer

This Instrument Comprises Means for Measuring and for Recording Foot-Pedal Pressure and Deceleration in Feet Per Second Per Second. The Decelerometer Element Is of the James Type. A Weight Is Mounted on Top of a Stiff Vertical Spring and the Movement of the Weight Is Conveyed to an Arm and a Pen, Causing the Pen To Move Across a Paper Strip That Is Driven by an Electric Motor. Pressure Is Measured by a Flattened Tube-Element That Carries a Pen Arm, Pressure Being Transmitted to This Element through a Copper Tube Connected with a Diaphragm Mounted on the Brake Pedal. A Liquid Is the Pressure-Transmitting Medium

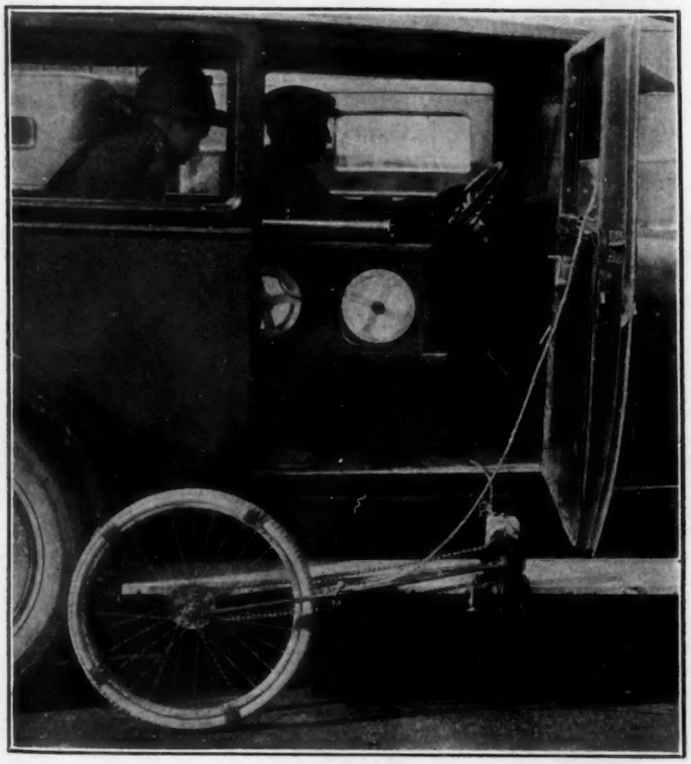

Fig. 8—Car-Movement Recording-Mechanism

This Is an Electrical Recording-Accelerometer Driven by a Fifth Wheel, the Apparatus Being Clamped to the Running-Board. The Pulley Ratio and the Internal Gearing Are Designed So That a Cam Operates an Ignition-Breaker Mechanism Every 1 Ft., and Another Cam Does the Same Every 10 Ft. of the Rolling Circumference of the Fifth Wheel. Due to the Low Inertia of the Fifth Wheel, No Measurable Slip Exists between Distance Traveled and Distance Recorded

Vibration is being studied by carrying on preliminary tests on the measurement of vibration by a telemeter adaptation. The telemeter is an instrument developed by the Bureau of Standards for measuring mechanical stresses electrically. The minute movement of a pendulum supported in a rigid block of metal that forms the frame of the instrument causes a change of resistance balance between two stacks of carbon discs. Current values are built-up by an amplifying and rectifying circuit so as to read directly on a milliammeter. Readings are taken against speed. Up to the present, we have limited our experiments to the detection and measuring of engine vibrations transmitted to the body, and to the measurement of engine detonation at wide-open throttle on hill climbs. Along the same lines, we have been using radio microphones and circuits to obtain tangible readings on noise measurements inside the car.

Special Apparatus

With comparatively few months of operation behind us, we naturally have many plans for the future to acquire further information. This calls for additional special apparatus and testing equipment, some of which is now being designed or prepared. This additional equipment includes:

Photographic Set-Up.— The long-focus photographic set-up is used for determining and recording outline and appearance changes. This set-up involves a background that is cross-sectioned and arranged to photograph all cars to the same accurate scale. The long focus is necessary to reduce the distortion due to foreshortening, which is always present

FIG. 10—MEASUREMENT OF STEERING EFFORT
The Amount of Steering Effort Is Obtained by a Duplicate Steering-Wheel Device That Clamps to the Regular Steering-Wheel of the Car and Transmits Effort through Calibrated-Spring Plungers Arranged with Sliding Riders That Read Maximum Pressure in Either Direction

when the object being photographed has depth. Use is made also of the simultaneous reading of several instruments by interrupted exposures automatically made with a moving-picture camera.

Chassis Dynamometer.—This apparatus is used to provide for easy and rapid tune-up of cars prior to test, and to measure power depreciation and friction changes during tests.

Towing Dynamometer.—It is in the form of a trailer to be towed by the car on test and is used to provide means of supplying continuous drawbar load for radiator and cooling tests and endurance tests under sustained low-speed heavy-pulling. With the towing dynamometer and an altitude box around the carbureter, Uniontown-Hill and Pikes-Peak conditions can be readily duplicated on our test track.

Headlighting.—We are beginning road-illumination tests of headlighting, using the target procedure practised by the Royal Automobile Club in its headlight-rating tests.

Ventilation.—Measurement of ventilation comfort inside of closed cars under different operating conditions includes analysis for carbon-dioxide and carbon-monoxide contents under particular conditions.

Printing-Type Accelerometer.—The serious objection to our present equipment is the detection and counting of the high-tension-spark perforations in the record strip, which is a tedious job. It is felt that, by adapting the printing clock-mechanism, such as is used in astronomical work, a more convenient record can be obtained. This would be accomplished by having the fifth wheel continuously turn several printing dials arranged to rotate at a ratio of 1 revolution per foot, per 10 ft. and per 100 ft. of car travel. At ½-sec. intervals, the clock will cause an electrically operated hammer to strike the paper strip momentarily against revolving printing dials similar to the method by which the receipt slips are printed in a cash register. By this means the number of feet traveled from half-second to half-second will be printed on a paper strip, and this provides the basis for obtaining time, velocity and acceleration data.

ROADS

One other important feature of our test activities at the proving grounds is road durability under very severe traffic conditions. While we have approximately 10 miles of road exclusive of the dirt trail-roads, most of the test traffic comes upon about 5 miles of road, the speed loop and the concreted test-hills. This gives us a traffic density of about 1 car per min. for the 24-hr. day. The obvious thing is to change to having all roads hard-surfaced, but these would not provide a test layout comparable with conditions the users of cars have available. We must keep and use dirt and gravel roads to provide dust and mud conditions that we all know have an effect upon the durability of automobile engines and running gear, to saying nothing of the life of body finishes.

While it is impossible to cover in detail all the test work carried on at the proving grounds, we hope at least a superficial first-hand impression has been conveyed that the automotive industry is endeavoring, harder than ever before, to build into its products more value and useful utility by actual first-hand work on the road than was ever attempted in any other line of business.

FIG. 11—MEASUREMENT OF PEDAL PRESSURE
Clutch Pedal-Pressures Are Measured by a Simple Yoke-Device As Shown. A Spring Balance Carries a Maximum-Pressure Rider So That Pressure Can Be Applied under Standard Operating-Conditions and Readings Taken from the Instrument after the Car Is Brought to a Stop

Can Motorcoaches Relieve Traffic Congestion?

By Phil B. Harris[1]

Los Angeles Group Paper

ABSTRACT

TRAFFIC congestion is inevitable in a rapidly growing city in which nearly everyone owns an automobile and wants to drive it downtown every day. Only the widening and straightening of the streets and the regulation of traffic, including the prohibition of parking, can give relief. Removal of the street-cars from the surface to subways or elevated roads would afford very little relief, in the opinion of the author, because the places of the cars would at once be taken by the automobiles of persons who had not been in the habit of driving into the business district. Congestion, which on week days occurs in the business district, moves to outlying intersections of main thoroughfares on Sundays and holidays and causes delays there.

The object of the Los Angeles Railway Corporation in adopting motorcoaches was not to decrease congestion. The motorcoaches were installed as feeder lines in territory where transportation was needed but where the traffic was not sufficient to pay for the construction of a rail line. These feeder lines are being operated at a loss, however. A 10-cent-fare motorcoach line, operated with double-deck vehicles in which every passenger had a seat, and paralleled on either side at a distance of two or three blocks by a heavily patronized rail line, proved unsuccessful and single-deck motorcoaches, with the regular fare, were substituted.

Men in the electric railway transportation business are interested in determining where motorcoach service will best fit into their systems. Although the motorcoach lines have made serious inroads into the revenues of the interurban railways, the author believes that the latter will recover much of the business by removing the tracks from city streets, eliminating grade crossings and maintaining a fast, safe and comfortable service. But as the railway service is improved the conditions for motorcoach service will grow worse, because the highways will constantly grow more congested.

After comparing some of the major advantages of motorcoaches and electric street-cars in transportation service, the author asserts that the electric-railway companies believe that motorcoach lines have a future as feeders, but that to be successful they must be operated by the same companies that operate the rail lines. This not only makes for financial success but will give the public better transportation at a lower rate, with transfers from one line to another, than if the business is divided between competing companies.

CONGESTION always will be found in a city that is growing as fast as Los Angeles and where nearly everyone has an automobile and wishes to drive it downtown every day. Relief can come only from street widening or straightening and from proper traffic laws, such as prohibiting parking on certain streets. Removal of the street-cars from the surface to subways or to elevated roads would relieve the congestion very little, because the space vacated by the street-car would be occupied by the machines of persons who had not been in the habit of driving downtown but who thought that, as the street-cars were gone, more room would be available for their automobiles. The ones who will be greatly aided by traffic relief will be the street-car riders. Rapid transit will come, but it will require a long time and much money. On week days our delays occur mostly in what is called the congested area, but on Sundays and holidays the delays come at points farther out where the street-car lines cross the avenues.

The Los Angeles Railway Corporation did not adopt motorcoaches to relieve congestion but as an aid to its present rail system. These vehicles were installed as feeder lines in territory where it was certain that the traffic would not be sufficient to pay for a street-car line but where transportation was needed, for the simple reason that the motorcoach lines could be established for a smaller investment and because the operating loss would not be so large. On all such lines the fare is 5 cents with free transfers and they are being operated at a loss. The day of pioneering with street-car lines has passed. In the past, when a car line was built into a sparsely settled district, we knew that, as the district grew, we would get all of the traffic, but that is not the case any more; so many people use their automobiles that we must be sure the business is there, or soon will be, before a car line can be extended very far.

Studying the Field for Motorcoaches

As regards motorcoach lines with a 10-cent fare for those who are willing to pay more to ride on rubber and to be sure of having a seat, we started such a line on Figueroa Street, with double-deck motorcoaches of the finest uptodate type. This line was paralleled within two or three blocks on either side by two of the heaviest-traffic street-car lines of the company on which one can hardly ever get a seat at any time of the day and which are jammed during the rush hours. It was thought that many passengers would prefer to take the motorcoaches, which assured a seat and in which crowding was avoided, but they did not. Evidently the extra nickel looked bigger than a seat, with the result that the company had to take off the double-deck motorcoaches and put on single-deck vehicles. Now the traffic is growing very slowly.

Men in the electric railway transportation business are greatly interested in determining where the motorcoach service will best fit into the transportation system and have watched the progress of motorcoach lines closely. In certain districts they have made serious inroads, especially into the earnings of the interurban car lines, but, in my opinion, the interurban railways will, in time, recover a large percentage of the business by the adoption of improved methods, such as removal of the tracks from city streets, the elimination of grade crossings and the maintenance of a service affording speed, safety and comfort that the motorcoach never will be able to equal. As the electric railways are improved, however, conditions will become worse for the

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motorcoaches, because the highways will constantly become more congested.

Coach and Street-Car Advantages Compared

Motorcoach service within the city has many advantages over the present rail-service. The vehicles can be re-routed easily in case of a street blockade, one bad-order motorcoach does not tie up the rest of the vehicles on the line and delays due to "power off" are eliminated.

Advantages in favor of the electric car are that it costs less per car-mile to operate, fewer extra cars are needed to maintain service, and it rides easier than the motorcoach, unless the pavement over which the latter operates is very smooth; nor is the street-car so easily damaged in collision with other vehicles. Its greatest advantage over the motorcoach, however, lies in its ability to carry great overloads. A double-deck motorcoach seating 60 passengers must not carry more; one seating 30 can carry 40, but a street-car seating 48 or 56 can carry 100 or more, and a two-car train will take more than 200. This ability to carry overloads makes it possible to move the people in and out of the business district in the rush hours with the least delay.

What would the streets be like if three times the present number of cars were put on to carry the people home without crowding? Whether they were electric cars or motorcoaches, they could not be operated through the streets. We tried something like that last Christmas-time at the request of the city authorities to put on more cars, with the result that the people did not get home until an hour later than usual.

The electric-railway companies believe that the motorcoach has a future and that it is destined to fit in with the electric lines as feeders, where street-car lines will not pay but the public should have transportation, and as extra-fare lines. To be successful, the motorcoach lines of a city should be operated by the same company that operates the electric cars. This not only makes for financial success but gives the public better transportation, because passengers can transfer from one line to the other and the combination makes possible a lower rate than if the business is divided between two companies competing against each other.

THE DISCUSSION

Ethelbert Favary[2]:—The great problem is how to increase the traffic capacity of the streets, speed-up automotive traffic and enable electric surface cars to make better time and the traction companies to carry more passengers without increasing their equipment. How can all of this be accomplished with greater safety and comfort to passengers and with the least delay and the least capital outlay by the city? I submit the following suggestions for consideration:

(1) Have all of the electric surface cars run underground in the congested district. This would increase the traffic capacity of the streets from 30 to 40 per cent, would eliminate the danger to passengers when boarding or alighting from the cars, would avoid the stoppage of lines of vehicles following the cars, and would make it possible for the street-cars to run faster with safety

(2) Let the street-cars skip alternate stops during the rush hours. Mark the cars alternately *A* and *B* and have the *B* cars make the intermediate stops skipped by the *A* cars. The skip-stop schedule need not be followed in the downtown district nor during the non-rush hours

(3) In the congested downtown district have the subway tracks at intersections cross at different levels. This would further permit increase of car-speed by avoiding waits for cars to cross in front of one another

(4) Provide plazas in outlying districts where the tracks emerge from the subway, thereby avoiding the impeding of traffic at these places

(5) Let the railway companies meet the demand for surface travel by providing additional motorcoach transportation on the more congested downtown streets or within the subway district. The motorcoaches could start at the plazas where the subways emerge and run to the heart of the downtown district

(6) Run the electric cars as express service from the plazas to the downtown districts without stops in the rush hours. Passengers wishing to alight at intermediate points could disembark at the plazas and board the motorcoaches. This would still further reduce the running time of the electric cars and would decrease the crowding of the cars in the congested territory

Many persons in every city, I believe, would pay a double fare and ride in motorcoaches that would make better time and carry them nearer to their destinations than the street cars in preference to taking their own automobiles into the downtown section. On the other hand, more passengers would ride in the street-cars if they made better time.

I believe that the plan outlined would decrease traffic congestion by increasing the capacity of the streets, would increase the safety of those boarding and alighting from the street-cars, would enable the railways to carry more passengers with less crowding, and would increase the travel by both automobiles and street-cars, as persons living farther from the city would come into town more frequently to shop if they could do so in less time and with less hazard.

[2] M.S.A.E.—Consulting engineer, Moreland Motor Truck Co., Burbank, Cal.

THE STEEL INDUSTRY

All indications point to heavy railroad buying of steel in 1926, according to *The Iron Age*, such expected buying being sufficient to take the place of the construction work and its attendant steel buying that has featured the development of the steel industry in the current year. Operations in the steel industry at the moment are close to the 83 per cent of capacity established in October, says the same journal, the operations for the month exceeding those of September by more than 7 per cent. It is estimated that if the October rate is maintained, the 1925 output of steel ingots will exceed that of 1923 and may equal the war peak output of 1917, which was 43,619,000 tons.—*Economic World.*

Vol. XVIII January, 1926 No. 1

Notes on Crankcase Corrosion

By M. A. Thorne[1]

Service Engineering Meeting Paper *Illustrated with* Charts and Drawing

ABSTRACT

THERE is almost unanimous agreement that water in the crankcase is responsible for corrosion in internal-combustion engines. The quantity of water present in the products of combustion of the fuel is dependent upon the hydrogen content of the fuel, the mixture-ratio and the humidity of the air that enters the engine. The amount of water that may be condensed on the cylinder-walls or in the crankcase depends upon the effectiveness of the pistons and piston-rings in preventing gas leakage, the temperature of the cylinder-walls and crankcase and the extent of the breather action. Condensation of water from the gases of combustion will start at approximately 130 deg. fahr. when gasoline is the fuel used, and at 123 deg. fahr. when a 50-per cent mixture of gasoline and benzol is used. The relative freedom of some engines from water accumulation is due to their higher operating-temperatures or to the better interchange of air by breather action which results in dilution of the gases in the crankcase and consequent reduction of the saturation temperature of the gases.

Water alone will cause corrosion but the action may be accelerated by the formation of weak sulphurous or sulphuric acid. A reduction of the sulphur content of fuels is desirable but, even with more insistent demand for such reduction, time would be required to bring this about. The chemical activity resulting from this and other contaminants would be negligible if the formation of water were controlled effectively. Other troubles for which water is responsible would also be eliminated.

Much can be accomplished toward prevention of water accumulation by developing pistons that will reduce blow-by and retain their effectiveness in use. In addition, means should be provided to (*a*) reduce the warming-up period and maintain the crankcase temperature sufficiently high to prevent condensation and eliminate water from the oil, and (*b*) ventilate the crankcase. Water formed during the starting of the engine will thus be minimized and ejected later and only a small amount of vapor will be present in the engine when it is stopped.

Either air or steam-cooling, with provision for controlled heating of the crankcase, is favorable for the solution of this problem. The passing of preheated air through the crankcase has marked advantages. In existing equipment, radiator shutters and thermostatic control of the jacket-water temperature, continuous-oil-heating devices, oil-filters and ventilating will all contribute toward averting trouble. Methods that may be used for preventing condensation of water in engines also will reduce oil-dilution and effect a more efficient utilization of fuel and oil.

OCCURRENCE of corrosion in crankcases each winter for a number of years past has caused increasing concern to automobile dealers and distributers and the companies whose product has been liable to this evil. Corrosion, besides being responsible for an economic loss of considerable proportion, has caused great inconvenience and dissatisfaction among owners of cars that were affected and has resulted frequently in financial loss to both car-owners and dealers.

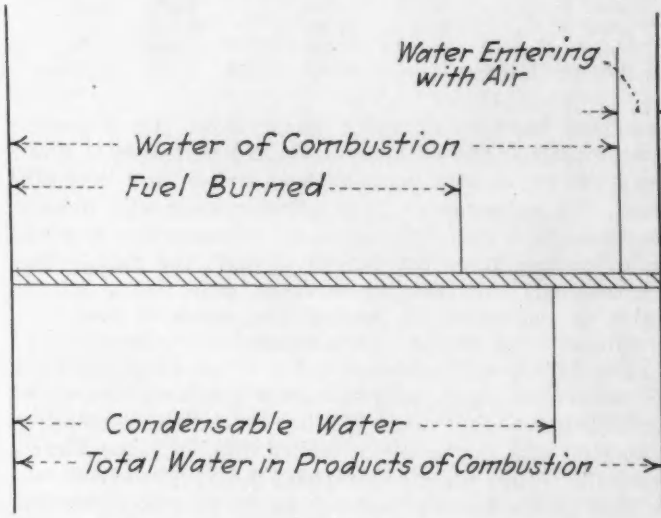

Fig. 1—Relative Values of Water Quantities in Products of Combustion

The Values Are by Weight, with Weight of the Fuel Burned as the Basis for Comparison. The Total Amount of Water in the Products of Combustion Is the Sum of the Water of Combustion and the Moisture in the Air That Enters the Engine through the Carbureter. The Quantity of Water Condensed Is Equal to the Total Quantity of Water Minus the Vapor Necessary To Saturate the Gases at Their Final Temperature in the Crankcase

Corrosion in the crankcase has been particularly insidious because of its obscure causes and the apparently contradictory conditions under which it occurs. As an example, it is natural for the manager of a service department to try to fix the responsibility for it upon a change in fuel, oil or operating conditions. He investigates and determines that no change has taken place in these. He is then confronted with the necessity of selecting a new clue, which he follows, usually, to a fruitless termination. Equally and as weirdly confusing is the fact that the higher-priced cars, which are justly associated in the mind with better materials, fit and workmanship, seem to be affected most frequently. All of these circumstances contribute to a sense of confusion and helplessness that usually attends efforts to avert a recurrence of the trouble. These evidences lend weight, however, to other factors that must be considered.

Symptoms and Effects of Corrosion

The symptoms and appearance of parts in engines that are affected severely are rather easily recognized. The first manifestation of trouble usually is an increase in engine noise, such as piston-slap, wristpin knocks and noisy valve-gear. Timing chains may become loose and require frequent adjustment. Coincident with these conditions, there is an increase in blow-by which may be noticeably audible or be indicated by the excessive amount of vapor that issues from the breather pipe. Upon dismantling the engine, examination discloses a corroded, pitted or rusty appearance of wristpins, valve-stems and valve-lifters. Clearances throughout the engine are found to have increased markedly. In several

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TABLE 1—WEIGHT OF WATER FORMED FROM COMBUSTION OF VARIOUS FUELS

Fuel	Content of Elements per Lb. of Fuel: Hydrogen	Carbon	Oxygen	Water Formed per Lb. of Fuel, Lb.	Air-Fuel Ratio
Hexane (C_6H_{14})	0.163	0.837		1.467	15.40:1
Pentane (C_5H_{12})	0.167	0.833		1.500	15.44:1
Dodecane ($C_{12}H_{26}$)	1.153	0.847		1.375	15.14:1
Alcohol (C_2H_5OH)	0.130	0.522	0.348	1.173	9.04:1
Benzol (C_6H_5)	0.077	0.923		0.692	13.40:1
Tuluol (C_7H_8)	0.087	0.913		0.782	13.62:1
Xylol (C_8H_{10})	0.094	0.906		0.850	13.79:1
Ether ($C_4H_{10}O$)	0.135	0.649	0.216	1.215	11.27:1

cases that have come under observation the clearance between pistons and cylinder-walls had increased to more than 0.020 in. in cars that had been driven less than 800 miles. The appearance of the cylinder-walls will, in very bad cases, be brown, the degree of discoloration depending, of course, upon the length of time the engine has been affected. All rubbing surfaces, with the usual exception of the camshaft, journal and crankpin bearings, are subject to corrosion. Occasionally the bearing areas of valve-lifters will show evidence of scoring but it is exceptional for other parts to have a similar appearance. It is difficult to determine whether or not the remaining surfaces in the engine are attacked, but it is considered improbable, since the comparatively heavy protective oil-film that covers them is not subject to frequent removal and replacement. The drained oil is very dark, almost black, has an excessive amount of sediment and, in most cases, a considerable quantity of a heavy emulsion, which is popularly termed "liver," is found clinging to the sides of the crankcase and lodged in various places throughout the engine. In milder cases the foregoing conditions are much modified and, for this reason, many cases of corrosion undoubtedly are attributed to other causes. The most frequent occurrences of corrosion are encountered in engines of six or more cylinders.

Water Condensation the Primary Cause

A survey of the published information concerning corrosion discloses an almost unanimous agreement that water in the crankcase is responsible. The source of this water, as is generally known, is the water vapor that is formed as one of the products of combustion. Pressures existing in the combustion-chamber during the power stroke are high and a portion of the gaseous products will escape to the crankcase, the quantity depending upon the effectiveness of the pistons and piston-rings in providing a seal. If the temperatures existing in the parts with which these gases come into contact are low enough, some of the water vapor will be condensed in the cylinders and become mixed mechanically with the oil-film on the cylinder-walls. Part of the gases will remain for some time in the crankcase, where further condensation may occur, and the rest, minus the water that has been condensed, will be forced out as more gases pass the pistons. Condensation will continue unless the engine temperature increases, and a considerable quantity of water may accumulate.

[2] See Bureau of Standards Technologic Paper No. 293, by Robert F. Kohr.

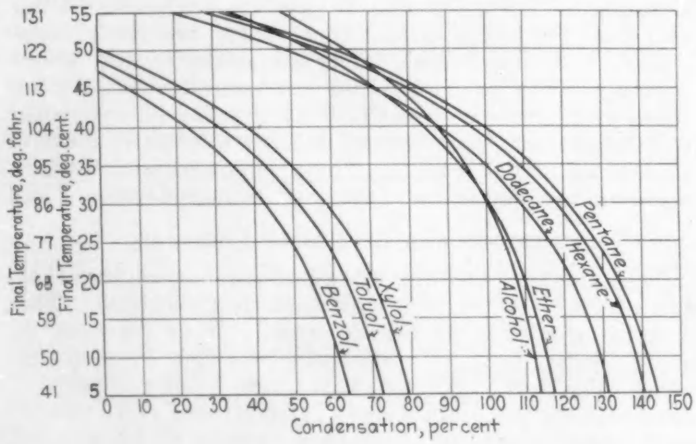

Fig. 2—Condensation of Water with Different Fuels

Condensation Is Expressed in Per Cent, by Weight, of the Fuel Burned, and the Curves Are Plotted Against the Final Temperature of the Products of Combustion in the Crankcase. The Rate of Condensation Is Much Greater at the Start of Condensation, Which Begins at About 130 Deg. Fahr., and Decreases Gradually as the Final Temperature of the Gases Drops. The Quantity of Water That Is Condensable Is Less for Benzol than for Dodecane, Which Most Nearly Agrees in Composition with Gasoline

Acid Formed from Sulphur in the Fuel

Although water alone will cause corrosion, the action may be accelerated by the formation of weak sulphurous or sulphuric acid. These acids are produced by the burning of the sulphur that occurs in fuel, thereby yielding sulphur dioxide and trioxide, and their subsequent combination with water. Contrary to the natural supposition that water from the crankcase should show a strong acid reaction, only very slight traces will ever be found. This has caused frequent confusion but can be attributed to the rapid combination of the acid with iron. Owing to the lack of a simple accurate method for determining the sulphur content in hydrocarbon fuels, relatively little information on this phase of the fuel problem is available. It is known, however, that the sulphur content generally will approach, and frequently exceed, the 0.1-per cent limit provided in Government specifications. The desirability of a decreased sulphur-content of fuels is unquestionable but, even with a more insistent demand for its decrease or for regulation of the percentage, considerable time would be required to effect a satisfactory reduction. The chemical activity from this and other contaminants would be negligible if effective control of the formation of water were possible. Other troubles for which water is responsible would also be eliminated.

Water Condensed from Gases of Combustion

The following data[2] are presented in this connection to point out the large potential source of water and to make clear the conditions that influence the amount which is formed as one of the products of combustion:

The chart shown in Fig. 1 represents the relative values, by weight, of the quantities indicated. In this and the subsequent charts, the fuel that is burned is the basis upon which other quantities are determined. The total quantity of water in the products of combustion is the sum of the water of combustion and the moisture entering with the air through the carbureter. This quantity depends upon the kind of fuel used and, to a small extent, upon the mixture-ratio. The quantity of water that is condensed depends upon the final temperature of the gas and is equal to the total quantity of water minus the vapor required to saturate the gases at their final temperature.

The weight of water that will be formed from the burning of any of a number of liquid fuels is shown in Table 1. The weight is based upon the assumption of a correct mixture of fuel and air for the complete combustion of each fuel. Dodecane more nearly resembles gasoline in hydrogen content than the other fuels listed.

The condensation of water from different fuels is

shown better by the curves in Fig. 2, in which the water that is condensed, expressed in per cent, by weight, of the fuel burned, is plotted against the final temperature of the products of combustion. The following assumptions were made in arriving at the curves shown: (*a*) chemically correct air-fuel ratio for combining and complete combustion, (*b*) relative humidity, 60 per cent and (*c*) entrance-air temperature, 15 deg. cent. (27 deg. fahr.) lower than the final temperature to which the products of combustion are cooled in the engine. The difference between atmospheric temperature and the temperature to which the gases are cooled in the crankcase is probably even more than 27 deg. fahr. This difference affects the quantity of moisture that is assumed to enter the carbureter with the air. The curves show that the rate of condensation is much greater at the start of condensation and gradually decreases. The quantity of water that is condensable is somewhat less for benzol than for dodecane, which most nearly agrees, in composition, with gasoline.

Mixture-Ratio and Humidity Have Slight Effect

The effect of variation in the mixture-ratio upon the condensation of water at various temperatures is shown in Fig. 3, in which the curves are plotted from gasoline that is assumed to have a hydrogen content of 15 per cent. A change of the mixture-ratio occasions little variation in condensation compared with the total quantity of water that is condensed.

Curves in Fig. 4 show the effect of variation in humidity between the limits of dry and saturated air when using a gasoline having a 15-per cent hydrogen-content with an air-fuel ratio of 13 to 1. Although this variation in condensation seems large, it should be borne in mind that atmospheric humidity does not vary so greatly as is shown in the chart.

Assuming rather extreme conditions with respect to mixture-ratio, humidity and entering-air temperature, with gasoline having a 15-per cent hydrogen-content, condensation will start at temperatures ranging from 145 down to 120 deg. fahr. Under ordinary conditions, however, condensation will begin at 130 deg. fahr. or slightly higher.

Factors affecting the quantity of water that is formed

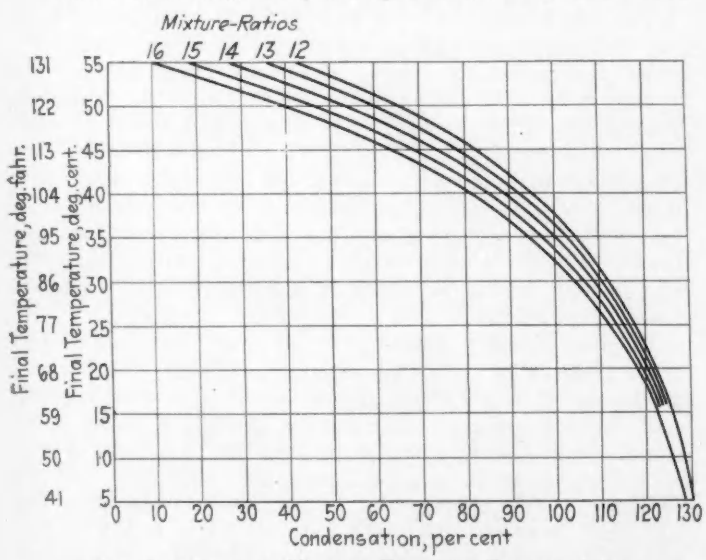

Fig. 3—Effect of Mixture-Ratio on Condensation
The Mixture-Ratio Is Shown at the Top of the Curves in Parts of Air to 1 Part of Fuel. As the Temperature of the Gases Decreases the Condensation Increases but the Rate of Increase and the Variation of Condensation with the Different Air-Fuel Ratios Decrease. Change of Air-Fuel Ratio Causes Relatively Little Variation Compared with the Total Quantity of Water Condensed

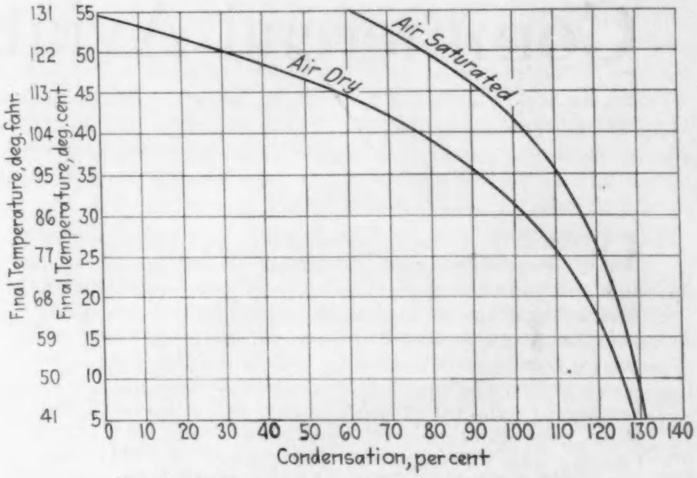

Fig. 4—Effect of Humidity on Condensation
Although Much More Water Is Condensed in the Engine When the Entering Air Is Saturated Than When It Is Dry, the Actual Atmospheric Humidity Does Not Vary So Greatly as the Extremes Shown in the Chart

in the products of combustion obviously cannot be controlled under the conditions that exist in ordinary service. Even the slight reduction that might be made would have little effect upon the quantity of water that would be condensed in the crankcase. The data given, however, serve to emphasize the importance of temperature in the application of methods for effectively preventing the condensation of water.

Crankcase Ventilation Will Reduce Water Volume

It is apparent that the water content of the products of combustion per unit of volume is several times the water content of an equal volume of air. The saturation temperature, and hence the temperature at which vapor will start to condense, are dependent upon the water content. This suggests the advantage of diluting the products of combustion that enter the crankcase. This could be accomplished by providing for the admission of air which would have the combined effect of displacing part of the gases and materially diluting and reducing the moisture content per unit of volume of the remaining mixture. This, in turn, would result in a lower saturation-temperature and consequently reduce the temperature at which condensation would begin. Four-cylinder engines are less likely to the accumulation of water than engines of six or more cylinders. It is not improbable that their relative freedom in this respect is due to more pronounced breather-action, which causes an interchange of crankcase air and gases. This would seem to indicate that the admission of a small volume of air would be sufficient to accomplish the desired result.

Blow-By Prevention the First Remedial Step

The first step that must be taken in providing remedial measures is obviously the development of pistons that will reduce the blow-by and retain their effectiveness during long periods of use. While the primary function of a piston is to provide an effective seal, it seems that this purpose is overlooked frequently in the desire to reduce friction or oil-pumping. In addition to minimizing the volume of gases that enter the crankcase, means must be provided to (*a*) reduce the warming-up period and maintain the crankcase temperature sufficiently high to eliminate water from the oil and prevent condensation and (*b*) ventilate the crankcase in such a way that every

(*Concluded on p.* 45)

Commercial Aviation's Present Phase

By D. W. Douglas[1]

Southern California Section Paper

ABSTRACT

DEFINING military, commercial and private aviation-activities and presenting an outline of aviation history to date, the author enumerates many factors that have tended to stimulate or to retard aviation progress and discusses present conditions and future trends. He considers 1925 to be the year 1 for commercial aviation in that conservative capital is investing in aviation projects, citing the commercial air-lines now in successful operation from Detroit to Chicago and Cleveland and our present Air Mail Service as examples, as well as the network of commercial air-lines abroad.

Aviation lessons learned during the war were the avoidance of loading airplanes with weights in excess of everyday possibilities, of laying out rosy schedules of operation that are thwarted easily by average bad-weather conditions and of carrying cargo that can be damaged irreparably. The last finds its application in that the latest and soundest aviation ventures are being inaugurated for carrying dead loads only and are not predicated on passenger carrying.

Lack of known constant factors for use in estimating initial costs, operating charges and maintenance expense constitutes a great present barrier to aviation progress, since a large part of the statistics for existing air-lines is complicated sufficiently to defy exact analysis; but the number of unknown quantities in the analytical equations is becoming less, and progress regarding the determination of proper equipment, of type of ground organization and of profits to be expected is becoming more rapid as the known and the constant factors increase. The World Flight of airplanes was productive of many essential data and the present Air Mail Service is now an important source of constants. The author believes that all the signs for the future are distinctly hopeful and that, within the next 2 years, cost constants under good and under bad management will be available for the determination in advance of what the profits from a given commercial-aviation project will be.

AVIATION activities can be classified as military, commercial and private and, at present, this is the order of their importance to the airplane-building industry. Military aviation is that branch concerned with the production and operation of aircraft for purely military purposes. Commercial aviation embraces all aviation activities that are engaged in for gain; it may be prosecuted by civilians or by the Government, as in the case of the Air Mail Service. Private aviation concerns privately owned airplanes, and is a minor phase because of the great cost involved.

The history of commercial aviation is of interest. In the strictest economic sense, commercial aviation preceded its as yet more extensive rival, military aviation. The first airplanes, both here and abroad, produced financial returns from exhibitions, civilian prizes and races, rather than from military uses. Until after the war, commercial aviation did not in any marked instance rise above a show affair. No air lines were operated, no mail or passengers were carried, nor were other every-day transportation-problems attempted. After the war, the flooding of the market with cheap war-time airplanes and the many pilots who had been discharged from service and were anxious to continue to fly brought on for a time many attempts toward successful ventures in aviation. No real economic success was achieved at this time. Few of the commercial operators of the past war-period made profits, or, making them, continued in the business when trade slackened. Aviation was "oversold" by war-time publicity. Either the ultimate in airplane performance was expected, predicted and counted on in commercial operations, or the thrill of aviation was stressed to induce curious people to fly. Air lines predicated as to pay loads and operating speeds on the "all out" habits of war-time military-operations soon failed because of every-day barriers to the realization of these ideal performances. The thrill-seeking element of our population was soon satiated as to joy rides, and the publicity of this phase of commercial aviation reacted on the more sober undertaking by fostering the idea of danger in the public mind.

The Air Mail Service, operated by the Government, was inaugurated at this time. It was continued and expanded throughout this period to the present, but suffered all the ills of civilian commercial aviation. Superior financial resources carried the Air Mail Service through to the present, but its operations were unsatisfactory, unreliable, dangerous and costly.

Post-war aviation suffered its slump also, largely due to poor or to unsuitable equipment and to unsound ideas as to ground organization and maintenance. The airplanes thrown on the market were built for military uses only and, while some of them could be converted to make admirable commercial-carriers so far as performance is concerned, they were not constructed with any thought toward durability or ease of maintenance. A short life and a high performance-ability formed the background of all war designs, as was proper. Nearly all commercial ventures were built around war-time pilots and mechanics who had no idea from their training that airplanes and engines could be other than short-time mechanisms; hence, in their organization and prosecution of commercial-aviation projects, they expected the worst of their equipment and received what they were looking for. In Europe, the experience was coincident in post-war aviation, but a greater need, perhaps, or a more daring public, aided to keep discouraged capital in the tottering air-lines and other civilian ventures. Subsidy also served to bolster-up failing aviation, and is still trying to make it more attractive so as to foster expansion.

In this Country, commercial aviation has languished from 1920 to the present, with but isolated instances of profitable or worthwhile ventures. A few "barnstormers" have weathered this period, profiting from occasional "taxi" work, motion-picture employment, aerial photographic-work and advertising, such as "smoke writing." The bright spot in the clouds has been the Air Mail Service. Through the last dark 5 years, our Air Mail Service has been progressing. Service was extended, bettered and made of economic value to the public. Safety and reliability standards were established that have renewed the faith of weakening aviation-capital. All this has been in spite of poor equipment

[1] President, Douglas Co., Santa Monica, Cal.

and difficulties of proper management because of Government control.

Present Status

In attempting to define the present status of commercial aviation, inclusive of the last 6 months, I mention future trends because, in aviation, the future is always next door to the present. As the airplane must always seek new air on which to glide, so must we seek future support for aviation when talking about its present condition.

The present phase of commercial aviation is one of unfolding wings. It appears that 1925 is the year 1 in commercial aviation, because capital of the most conservative kind—2-per cent capital, as the saying is—has gone into aviation definitely. Many men of the soundest business ability in this Country have invested in aviation ventures. The successful and expanding air-lines in Europe, where a network of useful air-lines is in daily and successful operation over thousands of miles of routes and over many different countries, constituted the blasting charge that opened to aviators the tightest pocket-books in America. These lines not only are accomplishing an economic benefit but also are fulfilling a political mission in that, by providing a swifter and less earthbound means of travel, they are welding together the different and antagonistic peoples. The unequaled success of our own Air Mail Service that spans our continent and operates day and night in winter and in summer with a regularity exceeding that of the limited trains between New York City and Chicago and has an astonishingly low mortality-record can be likened to a fuse connected with the blasting charge. By his establishment of commercial-air lines, Henry Ford can be said to have ignited the fuse and detonated the blasting charge.

Starting 6 months ago, Mr. Ford's airplanes have been operating on a daily schedule, carrying his own cargoes between Detroit and Chicago and, later, between Detroit and Cleveland. He has announced his intention of expanding this service eventually to link all his assembly plants in this Country. His operations have demonstrated the efficiency and regularity of air transportation when it is financed and managed properly. To date, his airplanes have flown more than 150,000 miles and carried approximately 500,000 lb. of cargo, with no losses, with a higher percentage of regularity than that of the railroads, and at average speeds better than 90 m.p.h. or nearly three times the railroad's average speed. Mr. Ford's operations have demonstrated the performance that may be expected, and the fact of his having committed himself to an aviation-development program has overcome the last scruples of many cautious investors. With the Post Office Department contracting with strong civilian organizations for the carrying of mail by air, new groups are entering commercial aviation on a soundly financial basis.

Lessons Learned after the War

In all the new ventures, those interested are trying to apply the lessons learned after the war; that is, not to overload the airplane with weights in excess of everyday possibilities, not to lay out rosy schedules of operation that are thwarted easily by average bad-weather conditions, and not to carry cargo, the damaging of which is irreparable. By the last I refer to the fact that all the latest and soundest ventures are being inaugurated for the carrying of dead loads only and are not predicated on passengers. Every one realizes the many problems of equipment, maintenance and operation that remain to be solved by actual operations, and that the solutions must be found before human lives are risked. Thus, the present phase of commercial aviation can be seen to be a period of intense growth. It is all experimental as yet regarding proper equipment, type of ground organization and profits to be expected. Knowing enough of the former unknown quantities in the equations for equipment and for organization determination, we can now expect a quick and an easy solution of equipment and organization problems. It is impossible at this time to determine by known constants the gain to be expected in any operation, for we have no constants. We have apparently parallel indications and isolated examples but no proved constants of costs or of revenues to be expected. Unless this present stage of commercial aviation leads, within a year or two, to a profitable maturity, aviation will have again experienced a setback, since it is now at the point where it will stand or fall on profits alone.

Chances of Financial Success

To appreciate what the chances are of financial success, we should now attempt to sum up the isolated examples that are indicative of costs. In this Country, we naturally turn first to the operations of the Air Mail Service, confidently expecting a clear indication because this service has been under way for 5 years. Here we meet with a discouraging situation. The costs of our Air Mail Service operation are so impossible to analyze from a business standpoint that the results indicate nothing. Government expense-accounts are not made up as are those in a business organization. Many items of real expenditure are omitted because of allocation to other accounts or because of some peculiar condition whereby equipment that would represent an investment to a civilian organization constitutes an exchange with some other governmental bureau at no definite price. On the other side of the ledger, many extraneous charges are shown in a government venture that would not encumber a civilian operation. Then, too, with no charge of inefficiency against the Air Mail Service personnel, ponderous governmental business-methods result in losses or burdens on operating costs that would not occur in the present management of a civilian venture. So, from all our Air Mail Service operations we can get only the general data on airplane and engine life, and we find even those data none too clear. It is our first assurance, however, of the possibility of carrying a commercial load by air at a reasonable cost.

Foreign air-lines also seem to have had enough experience to give us some constants of operation costs. Like our Air Mail Service, however, they are semi-governmental affairs. The subsidies they receive obscure many facts, and also cause many inefficiencies. At times, operations are maintained for the purpose of collecting a subsidy and not for filling a needed service. We learn, then, from Europe, only such things as expectance of airplane and of engine life but not maintenance and operation costs.

Of late years, small appropriations for our Air Service have resulted in the necessity of conserving its equipment. This has been reflected to the aircraft designers and builders in demands for more durable airplanes that can be maintained more easily. This demand culminated and was expressed by the Air Service in its epochal undertaking in making the World Flight, which was a test of modern airplane materials, of design, of details, and of construction, under the most trying conditions. It was a problem in organization and mainte-

nance, the solution of which was to prove or disprove the accepted opinions of Air-Service specialists in these lines. It did prove that the Air Service had advanced mightily in these lines since the war, and also brought forth other ideas that have had and will have a lasting effect on organization and maintenance. The World Flight is commercial aviation's best maintenance and organization factor to date, and it is an encouraging factor. Airplane detail-design, proper to give long life and easy maintenance, has been indicated by the World Flight in a manner that leaves no question of its meaning. In the last few years the Air Service has aided in other ways in solving the primary unknowns in the cost equation of airplane operation. Maintenance and overhaul records at supply and repair depots have established, to some extent, what to expect of airplane and of engine operation. However, absolute costs again are misleading, as in the case of the Air Mail Service operation.

During the last 5 years, a handful of able and earnest civilians have operated "shoestring" commercial-aviation ventures. The few who have survived and made profits have established what can be done in their particular cases. Here again we cannot reduce their costs to constants that can be applied to any given operation-problem solution, as so many conditions are variable and affect the constant. The small venture, often of a nature involving only part-time use of equipment, is burdened with higher interest-charges than is the ideal large operation which, as in any other thoroughly well-organized commercial-operation, uses its investment to its limit. On the other hand, the struggling operator makes economies impossible of realization in larger projects, and realizes an efficiency of labor, based on necessity for existence, that larger organizations cannot expect to attain.

Henry Ford's air-lines have indicated costs that are in keeping with those determined by the aid of all these other cost indications; but since his operations have existed for 6 months only, it is early to accept them as maxims.

Future Possibilities

All the signs for the future are distinctly hopeful. The cost of a commercial operation over a predetermined route, with known equipment and with presupposed good management, can, we believe, be approximated closely enough to form a basis for a beginning. Some careful financier has said, however, that no business is a safe one that will not yield a profit with poor management. Undoubtedly, in the next 2 years, we will have cost constants under good and under bad management, and we wonder what our margin of profit will be.

More uncertain than the determination of operating costs is the estimation of revenues to be expected. As mentioned previously, most ventures now being launched in commercial aviation are predicated on their ability to secure sufficient air-mail or express, and not on a volume of passenger traffic by air. Most of these new organizations have expectations, not of making large profits from this dead cargo, but of making their carrying costs from it to enable them to blaze their trails, perfect their organization and equipment and live to see the day when they can solicit passenger traffic without fear of ensuing catastrophies. The ability of these organizations to do this will depend upon the public, upon performance, advertising and their own resources. The public has indicated by its use of the Air Mail Service that it will support air lines in certain localities. Advertising and better performance are relied upon to increase the present use of the Air Mail Service. Every sober consideration indicates that, even granting the best expectations from the public in the matter of patronage, only strongly financed commercial-airplane companies can weather this next period of exploitation. "Shoestring days" are over and, if commercial aviation in its present phase of large operation fails, the dark days to follow will be darker and longer than any that aviation has yet experienced.

MEETINGS OF THE SOCIETY

(*Continued from p.* 26)

Hupp Method of Lapping

In outlining the method used by the Hupp Motor Car Co., Dan Smith explained that the reaming of cylinder-blocks is performed in four operations, the amount of stock left by the finishing reamer being from 0.002 to 0.003 in. Although more than some other manufacturers leave, this amount has been found necessary for the removal of all trace of feed-marks. The lapping of the eight-cylinder block is done by a four-spindle machine and that of the six-cylinder block with three spindles, the work being shifted for alternate bores because of the space required for a special-style lap.

Under their conditions, Mr. Smith said that the positive type of lap with cone adjustment had been found to be best. The cones are operated by a threaded shaft connected to an operating collar 6 in. in diameter. Each lap carries six 0.5 x 4.0-in. stones made of carbide of silicon, 120 grit. The operator enters the laps in their respective bores by raising the machining table, opens each lap against the cylinder-wall and starts the machine. The spindles rotate at 360 r.p.m. with 55 reciprocations per min. The stroke is 5.50 in. for a bore 3.00 x 7.25 in. The laps, therefore, have a spiral cutting-action. Midway on the downward stroke the adjusting-collar makes contact with two bronze shoes, having an adjustable spring-tension and being located on the bushing-plate in such a manner as to form a V. These friction shoes maintain the cutting-tension until the operating-collar touches the stop. A micrometer adjustment on the stop makes it convenient for the operator to compensate for the wear of the stones. In stopping the spindles at the top of the stroke, the collar makes an extra turn under its own momentum and automatically releases the tension.

With this method of lapping, all feed-marks are removed. The tolerance is 0.00025 in. for out-of-roundness and 0.00050 for taper. To maintain these limits a single-spindle machine having the same type of lap is necessary to correct any errors that may be found after the block comes from the multiple-spindle machine.

Two men can lap 238 eight-cylinder blocks per day, whereas two men grind 28. The maintenance cost of lapping, however, is much higher than that of grinding, because of the heavy load on the machine and the short life of the stones. Up to the present time, the predicted economy has not been obtained, but because of the better finish and closer limits a continuation of the present method is favored.

(*Concluded on p.* 52)

Dilution Effects on Friction Coefficients and Bearing Temperatures

By Albert Le Roy Taylor[1]

Illustrated with Photographs and Charts

ABSTRACT

TESTS made to ascertain the degree of crankcase-oil dilution beyond which it is unsafe to run an engine bearing are described and the data obtained are analyzed, the details of the apparatus used being specified. To study the effect of dilution only, new oil was used in each case and was diluted to the desired extent by adding to it the proper quantity of diluent; that is, samples of oil obtained from engine crankcases were distilled by heating, and the distillates were used to dilute the new oil. The apparatus used for distilling the crankcase oil was an ordinary glass still, which was operated in conformity with standard methods. Four lines of investigation were followed in making the tests, these being outlined.

In general, the results of the tests indicate that dilution of the oil up to 50 per cent has no bad effect upon the engine as regards increased friction and temperature of the bearings, although the dilution may be injurious from other standpoints. It appears that dilution of the oil does not affect the friction or the bearing temperature materially so long as a film of oil can be maintained between the surfaces. When this film breaks down, both friction and temperature increase. The tests indicate that the film does not break down until the oil becomes highly diluted if the pressure is low; but, when the pressure is increased, the diluted oil seems to be squeezed out from between the surfaces more easily, so that friction and temperature are higher.

THE statement that burned-out bearings are caused by the dilution of the lubricating oil, or by what is commonly called "crankcase dilution," has been made many times in textbooks and trade journals, and by mechanics and others. If this statement is true it appears that there should be some degree of dilution beyond which it is unsafe to run a bearing, and the original purpose of the tests described in the paper was to determine this point.

Two principal ways exist in which an internal-combustion engine may be affected adversely due to dilution of the crankcase oil. First, the condition of the oil may destroy or interfere with the seal between the piston-rings and the cylinder, thus causing loss of compression, loss of power and other detrimental effects. Second, the diluted oil may increase the friction which, in turn, will cause an increase in bearing temperature to the extent that the wear at these surfaces may be excessive and, in the extreme case, the temperature may be so high that the bearings are burned-out.

A considerable amount of experimental work has been done along the line of the first cause; so, the author made no investigation of it. However, little, if anything, appears to have been published relative to the effect of dilution on the friction and bearing temperature. It is, therefore, the purpose of the paper to describe some experiments that were made to determine these effects.

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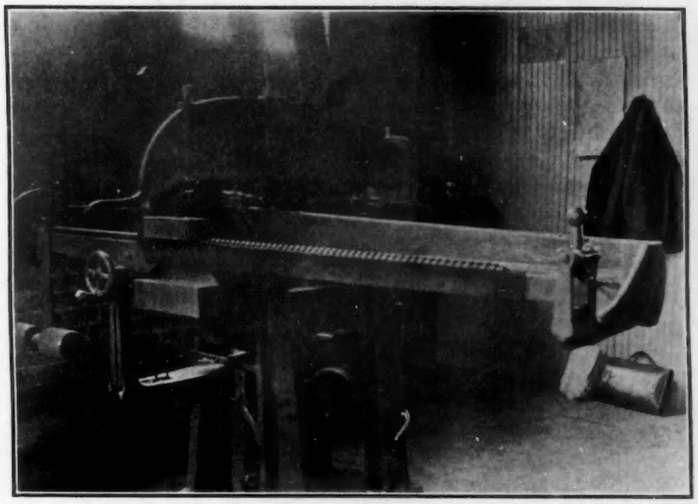

Fig. 1—Cornell-Olsen Oil-Testing Machine

A Steel Journal Is Fastened upon a Shaft Mounted between Bearings and Driven by a Pulley Keyed to the Shaft between One of the Bearings and the Journal. A Countershaft Drives the Pulley, the Two Speeds of 210 and 325 Ft. per Min. Being Obtainable. A Step or Bearing Rests on the Journal and Is Mounted in a Yoke That Rests on Knife-Edges in the Line of the Shaft. Pressure between the Journal and the Step or Bearing Is Produced by a Helical Spring, the Length of Which Can Be Varied So As to Vary the Pressure. When the Journal Turns, the Friction Tends To Swing the Yoke about the Knife-Edges, Which Tendency Is Balanced by a Scale Beam Calibrated So That the Amount of Friction Can Be Read Directly, As Indicated by a Pointer. The Bearing Block Is Drilled To Receive a Thermometer for Recording Bearing Temperatures

Apparatus Used

The tests to determine the coefficient of friction and the temperature of bearings were made on a Cornell Olsen oil-testing machine in the laboratory of the University of Utah. This machine, which is illustrated in Fig. 1, consists essentially of a shaft upon which is fastened a steel journal 3¾ in. in diameter and 3½ in. long. The shaft is mounted between bearings and driven by a pulley keyed to the shaft between one of the bearings and the journal. This pulley is driven from a countershaft from which, in the case of this particular machine, two speeds were obtainable, namely: 210 and 325 ft. per min. A step or bearing rests on this journal and is mounted in a yoke that rests on knife-edges in the line of the shaft. Pressure between the journal and the step or bearing is obtained by a helical spring, the length of which can be varied so as to obtain pressures between the bearing and journal varying from no load to a load of 5000 lb.; these pressures are indicated by a pointer on the spring, which operates over a scale attached to the housing of the spring. When the journal turns, the force of friction tends to swing the yoke about its knife-edges, which tendency is balanced by a scale beam. This is calibrated so that the amount of the friction can be read directly. The coefficient of friction is therefore the beam reading in pounds divided by the total load from the spring, which is indicated by a pointer on the case surrounding the helical spring. It is possible to balance the beam within about 0.5 lb., giv-

ing an accuracy for the values obtained in these tests of from 1 to 3 per cent. To avoid having the journal become grooved, it is given a transverse motion relative to the bearing. This is accomplished by a cam.

The bearing material used in these tests consists of two strips of babbitt metal, each ½ in. wide by 3½ in. long, making a bearing area of 3½ sq. in. The bearing block is drilled to receive a thermometer for recording bearing temperatures.

Method of Preparing the Oil

It was realized that oil drained from crankcases might contain, besides the liquid diluent, carbon, grit and other foreign matter, the influence of which it was desirable to eliminate as it was the purpose to study the effect of dilution only. For this reason new oil was used in each case, diluted to the desired extent by adding to it the proper quantity of diluent. For obtaining the diluent, samples of oil taken from engine crankcases were distilled by heating between the "end-point" temperatures of present-day fuel. This material was then used to dilute the oil. The apparatus used in distilling the crankcase oil was an ordinary glass still, which was operated in conformity with adopted standard methods.

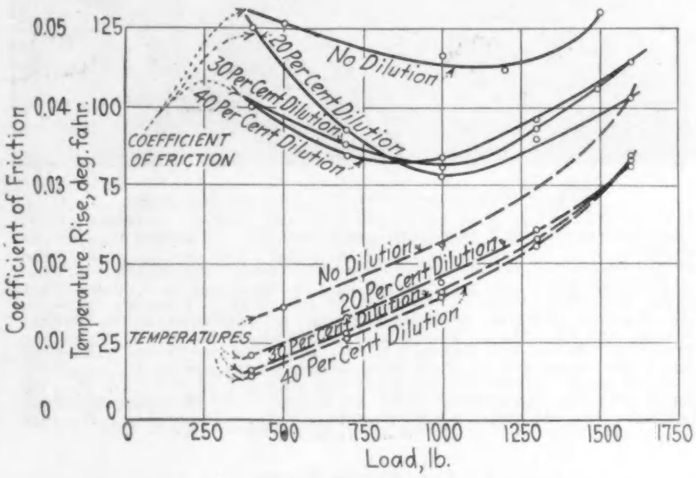

FIG. 2—OIL SAMPLE NO. 1. SPEED, 210 FT. PER MIN.
Variation of the Coefficient of Friction with Load, and Increase of Temperature with Load at Various Dilutions

Methods of Testing

Four lines of investigation were followed in making the tests. In the first method, the Cornell Olsen testing-machine was adjusted for a load of about 500 lb. and the journal was run at the lower speed while being supplied with undiluted oil at a constant rate. The initial temperature was observed, and the beam was balanced to obtain the friction. Running at this load was continued for 15 min. and the temperature was again recorded. The load on the journal was then increased and a second set of similar observations was recorded. Other runs at increasing loads were then made, the load being increased to an amount at which the temperature rise made further loading prohibitive.

A similar set of observations was made by running the journal at the higher speed, 325 ft. per min. This complete set of runs was then repeated for each different dilution of the oil. The number of runs and the degree-of-dilution runs for each oil depended largely upon the results obtained, and in some cases these indicated the desirability of obtaining points on the curves at closer intervals than in others. Four different oils were tested

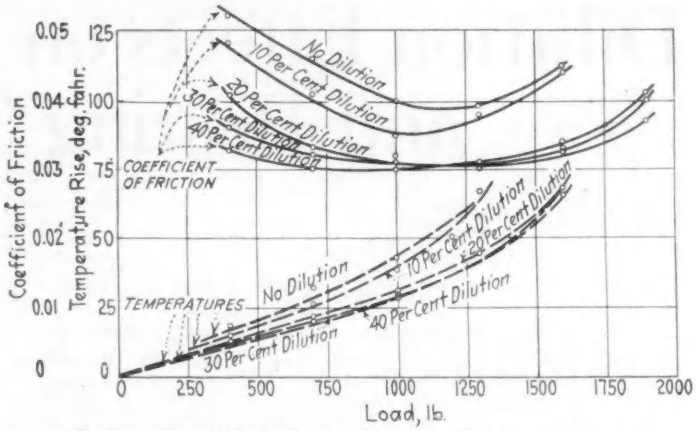

FIG. 3—OIL SAMPLE NO. 1. SPEED, 325 FT. PER MIN.
Variation of the Coefficient of Friction with Load, and Increase of Temperature with Load at Various Dilutions

by this method, the results being shown in Figs. 2 to 9. Data on their viscosities are given in Table 1.

TABLE 1—VISCOSITIES OF OILS USED

Number of Sample	Viscosity at 100 Deg. Fahr., Saybolt Universal Sec.
1	649
2	263
3	200
4	750
5	750
6	450
7	196

As the results obtained by the first method were rather different than had been expected, that is, with most of the samples, and as a decided tendency was noticed for the coefficient of friction to decrease and for the temperature rise to decrease with diluted oil over that obtained with pure oil, rather than for these items to increase with dilution, it was thought wise to use a different method so as to check the other results.

The second method used was as follows: The machine was started and a load of 1000 lb. was put on the bearing, using undiluted oil. The machine was run under these conditions until the temperature of the bearing remained constant. The temperature and the friction were recorded, the machine was stopped and the bearing and the journal were quickly washed clean of all the old oil, with gasoline. Then, the machine was started again under the same load and speed conditions, but with the

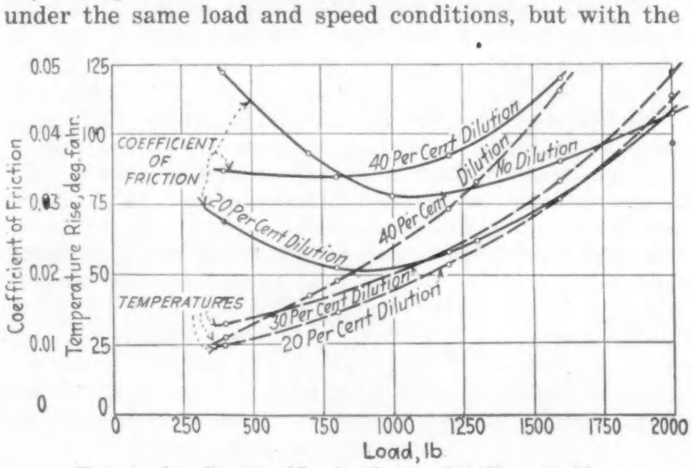

FIG. 4—OIL SAMPLE NO. 2. SPEED, 210 FT. PER MIN.
Variation of the Coefficient of Friction with Load, and Increase of Temperature with Load at Various Dilutions

oil diluted. This run was continued until the temperature was again constant. As before, the journal and the bearing were cleaned and another run was started with oil of a higher dilution. This process was continued until an oil of a high dilution was used. In one case, a run was attempted with 100 per cent of dilution; that is, with no oil, but all diluent. It was not possible to continue this run until a constant temperature was reached, for, within 2 min., the temperature had increased to a point at which it was not safe to run the bearing longer. The coefficient of friction increased to 0.10.

One peculiar condition was noted in these last runs. Each time the machine was started after being supplied with a fresh oil, the friction seemed to be greatly increased and the temperature rise was very rapid. These both decreased after a few minutes of running and the coefficient of friction became constant. The results of the second method of tests are shown in Fig. 10.

When beginning the third series of tests I had thought to obtain data that would indicate the degree of dilution beyond which it would be unsafe to run a bearing and,

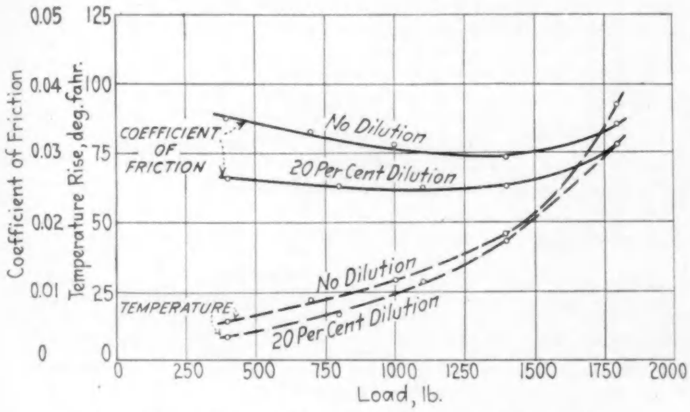

Fig. 5—Oil Sample No. 2. Speed, 325 Ft. per Min.
Variation of the Coefficient of Friction with Load, and Increase of Temperature with Load at Various Dilutions

as a check on the anticipated results, I wrote to six of the large repair shops, asking if they would cooperate with me in this investigation by sending a sample of the oil drained from the crankcase of an engine whenever they had for repair an engine with burned-out bearings if the failure could in any way be attributed to the condition of the lubricating oil. Five of these firms replied that they would be pleased to cooperate and were, therefore, furnished with sample bottles.

The fourth set of tests was to determine the degree of dilution common in practice. A number of people were asked to submit samples of oil for this purpose when they drained the crankcases of their engines. It was definitely stated to them that they were not to let this request influence them in draining the crankcases, but that they were to drain the oil when they thought it necessary.

Analysis of Results

By reference to Figs. 2 and 3 it will be observed that, for oil sample No. 1, which was a heavy oil having a viscosity of 649 Saybolt universal sec. at 100 deg. fahr., at loads below 850 lb. or a pressure of 243 lb. per sq. in., the coefficient of friction decreased with each increase of the percentage of dilution of the oil. The amount of the decrease becomes less as the load increases and, at an 800.0-lb. load, or a pressure of 228.6 lb. per sq. in., the graph of coefficients, at 30-per cent dilution and above,

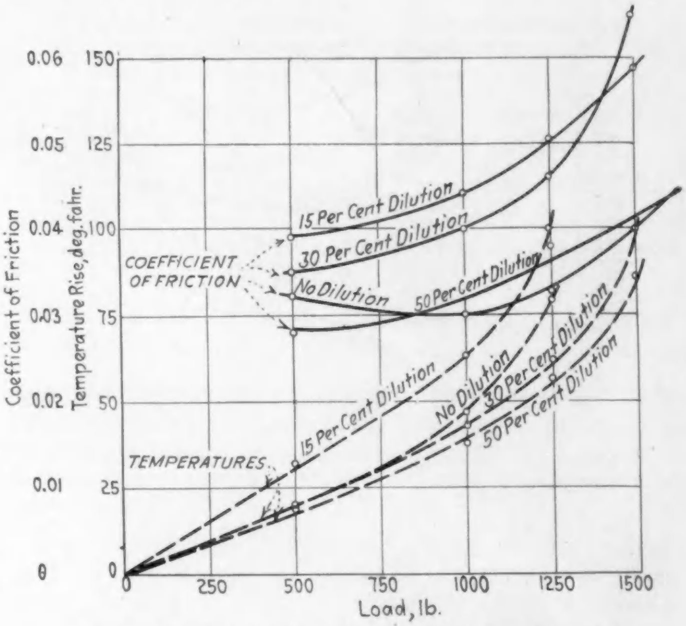

Fig. 6—Oil Sample No. 3. Speed, 210 Ft. per Min.
Variation of the Coefficient of Friction with Load, and Increase of Temperature with Load at Various Dilutions

crosses the line of the 20-per cent dilution, and the coefficients of these higher dilutions are greater. The curves for the temperature rise of the bearing are consistent with those for the change in the coefficient of friction and show a lower temperature-rise with increasing dilution of the oil up to 40-per cent dilution, at which the temperature rise increases over that for lower dilutions.

It seems that, at loads up to about 1200 lb., or a pressure of 343 lb. per sq. in., dilution of oil has no tendency to increase the friction; but, above this pressure, the oil seems to be partly squeezed out from between the surfaces, causing an increase in the friction and an increase in the temperature of the bearing, although the increase is not to a value greater than that obtained for the undiluted oil at the same pressure. The results of tests of the same oil at a higher speed, as shown in Fig. 3, are similar to the values just discussed and lead to the same conclusion.

Oil sample No. 4 was also a heavy oil, having a

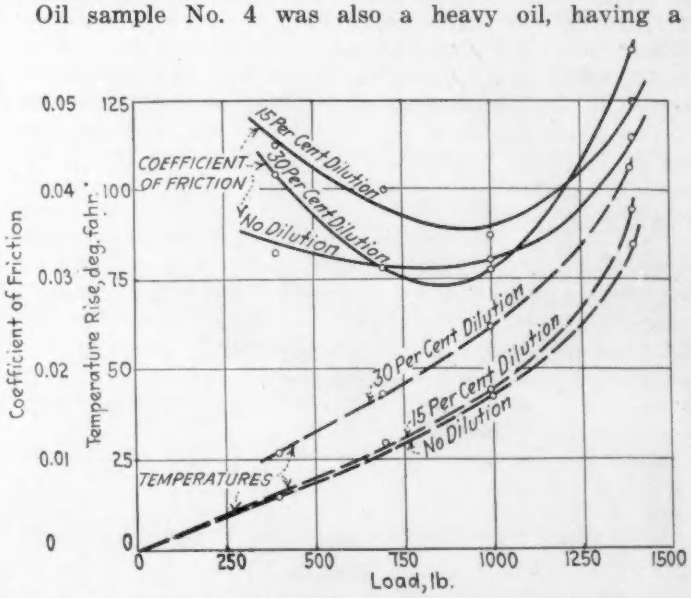

Fig. 7—Oil Sample No. 3. Speed, 325 Ft. per Min.
Variation of the Coefficient of Friction with Load, and Increase of Temperature with Load at Various Dilutions

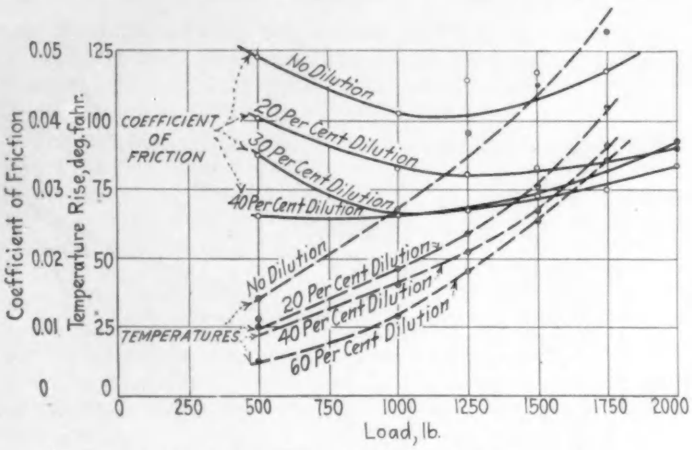

FIG. 8—OIL SAMPLE NO. 4. SPEED, 210 FT. PER MIN.
Variation of the Coefficient of Friction with Load, and Increase of Temperature with Load at Various Dilutions

viscosity of 750 Saybolt sec. at 100 deg. fahr., and the results are similar to those for oil sample No. 1. The decrease in the coefficient of friction is greater, however, for each dilution, changing at a load of 500 lb. or a pressure of 143 per sq. in., from 0.049 to 0.026. The temperature rise is also more pronounced. The effect of the higher pressure on the more highly diluted oil is very apparent in Figs. 8 and 9.

Oil sample No. 3 is of a very light oil, having a viscosity of 200 Saybolt sec. at 100 deg. fahr. The results here are rather more difficult to interpret, as they do not seem to run as consistently as do those for heavy oils. It appears that with this light oil the film had a tendency at times to break down or to fail to form completely. It does seem safe, however, to say that the results of this test show no appreciable increase of friction or serious temperature-rise for loads below 1000 lb., or a pressure of 286 lb. per sq. in. For pressures above this value, temperature troubles may be experienced.

Oil sample No. 2 was a light oil, having a viscosity of 265 Saybolt sec. at 100 deg. fahr. The action of this oil was somewhat similar to that of the heavier oils except that the coefficient of friction for 40-per cent dilution and above rises at higher pressures above the value for the coefficient of friction for the undiluted oil at the same pressure. In the case of this light oil it seems safe to say that, for loads below 1000 lb., or a pressure of 286 lb. per sq. in., no increase of friction with dilution of the oil up to a dilution of 40 per cent, and also no increase in the temperature of the bearing over that with

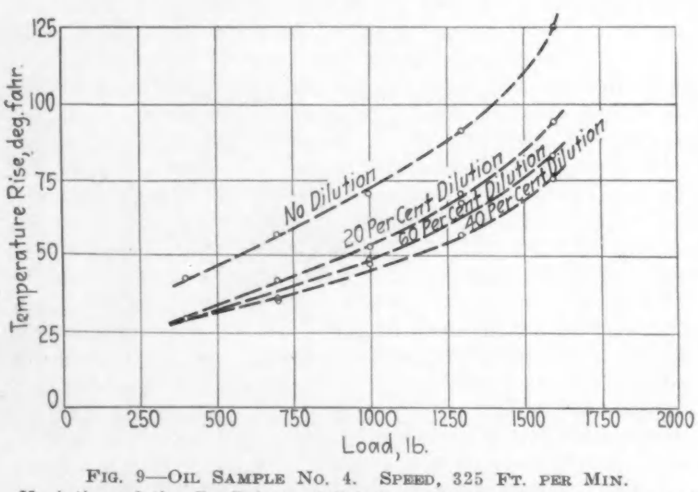

FIG. 9—OIL SAMPLE NO. 4. SPEED, 325 FT. PER MIN.
Variation of the Coefficient of Friction with Load, and Increase of Temperature with Load at Various Dilutions

undiluted oil was apparent; but that, at pressures above this value, trouble may be experienced, from both the increased friction and the bearing temperature.

Oil samples Nos. 5 and 6 were of heavy oils, having viscosities of 750 and 450 Saybolt sec. respectively, and were tested by the second method already outlined. By reference to Fig. 10 it will be observed that, in the case of sample No. 5, the coefficient of friction is nearly constant, falling only slightly up to a dilution of 40 per cent but then rising more abruptly. The temperature curve is similar.

In sample No. 6, the decrease in the coefficient of friction and decrease in the temperature are both more pronounced up to the 40-per cent dilution. At values above this, there is an increase in both cases. The curves for these oils indicate that, above a 60-per cent dilution, the coefficient of friction and the temperature of the bearing are both greater than for the undiluted oil; but for the dilutions below 60 per cent, the lubrication, so far as friction and temperature are concerned, is as good as that for the undiluted oil.

Sample No. 7, having a viscosity of 196 Saybolt sec.

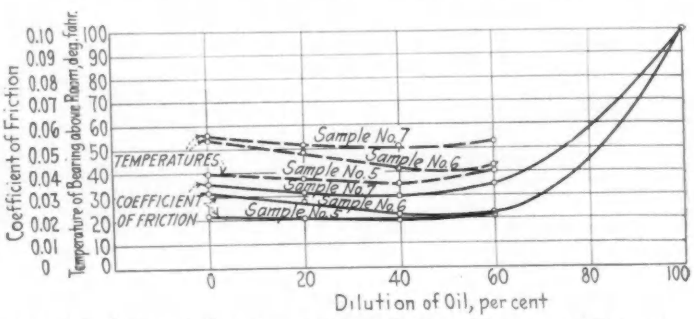

FIG. 10—RESULTS OBTAINED BY THE SECOND METHOD OF TESTING
Tests Were Made of Oil Samples Nos. 5, 6 and 7, To Obtain Changes in the Coefficient of Friction and the Temperature of the Bearing with Different Oil Dilutions. The Load on the Journal Was 286 Lb. per Sq. In. and the Speed of the Journal Was 210 Ft. per Min.

at 100 deg. fahr., which was also tested by this method, is for a light oil. Here again the results are similar to those obtained for oil samples Nos. 5 and 6, except that the coefficient of friction is higher and the temperature rise greater at all dilutions. This is more marked at 60-per cent dilution, indicating as before that the lighter oils cannot be used at as high a degree of dilution as the heavy oils.

In a period of 7 months, only one sample of oil drained from crankcases was submitted from the various shops that were asked to cooperate in this matter, as previously mentioned. Thinking that the reason for receiving so few samples might be due to neglect on the part of their representatives, I interviewed them but was assured in each case that burned-out bearings which could be attributed to the failure of the oil had not occurred. The one sample submitted had a dilution of 18 per cent and did not seem to be responsible for the failure of the bearing. These results then indicate that in general bearings do not tend to burn-out due to the dilution of the oil in the amounts that it usually is diluted in practice.

The results of the tests to determine the dilutions that existed in practice are recorded in Table 2. Analysis of these results shows that the degree of dilution varied from 28 to 60 per cent. Each engine was apparently operating satisfactorily up to the time the crankcase was drained.

GENERAL CONCLUSIONS

From the results of the tests made it appears that, with oils generally used for automobile-engine lubrica-

tion, whether light or heavy in grade, no increase in the friction nor increase of the bearing temperature for dilutions of the oils up to 60 per cent occurs, provided the bearing pressure is not in excess of 286 lb. per sq. in. Bearing pressure in automobile engines is usually not in excess of this figure. With heavy oil, this bearing pressure may be increased considerably. Many machines are in operation using oil diluted between 25 and 50 per cent, and are experiencing no apparent ill effects from this dilution. The tendency to attribute burned-out bearings and scored cylinders to dilution of the oil does not seem to be justifiable. In general, the results of these tests indicate that dilution of the oil up to 50 per cent has had no bad effect on the engine insofar as increased friction and temperature of the bearing are concerned. This dilution may be injurious from other standpoints, such as loss of power due to leakage past the piston and the like, but any disadvantage is not apparent along the lines that have been investigated in these tests.

It seems that dilution of the oil does not affect the friction or the bearing temperature materially so long as a film of oil can be maintained between the surfaces. When this film breaks-down, both friction and temperature increase. The tests indicate that the film does not break-down until the oil becomes highly diluted if the pressure is low; but, when the pressure is increased, the diluted oil seems to be squeezed out from between the surfaces more easily, so that friction and temperature are higher. It appears also that, in the case of light oils, the film breaks-down more easily than in the case of heavy oils, as might be expected. It is interesting to note that, in starting with a dry bearing, some considerable time is necessary for the establishment of the film between the two surfaces, but as soon as the film is once established, conditions remain constant.

TABLE 2—DISTILLATION DATA OF OILS DRAINED FROM AUTOMOBILE CRANKCASES

Number of Sample	Miles Run	Grade of Oil	Dilution, Per Cent
1	875	Heavy	31
2	650	Medium	51
3	1,750	Heavy	60
4	1,100	Heavy	49
5	825	Heavy	28
6	500	Light	30
7	600	Medium	31
8	500	Medium	40
9	800	Heavy	42
10	900	Heavy	36

NOTES ON CRANKCASE CORROSION

(*Concluded from p. 37*)

part will be reached by the air and the possibility of localized condensation be reduced. The condensation of water when starting the engine under cold conditions will thus be minimized, the water formed will be ejected later, and only a small quantity of vapor will remain in the engine when it is stopped.

High Operating and Oil Temperatures Help

Either air or steam-cooling offers favorable conditions for the solution of this problem. The warming-up period is relatively shorter with either system than with water-cooling, and high operating-temperatures are assured. Steam-cooling, particularly, affords an easy means of providing for controlled heating of the crankcase by a heating coil immersed in the oil or by circulating steam around a jacketed oil-pan. In the case of water-cooling, the thermostatic control of jacket-water temperature serves to shorten the warming-up period and maintain a higher operating-temperature, not only of the cylinder-walls but of the crankcase also. Either manually or thermostatically controlled radiator shutters serve a similar purpose. Venting the crankcase at points where localized condensation might occur has been resorted to in a number of cases with varying success. Had openings of adequate size been provided to ensure a greater degree of ventilation, it is probable that more satisfactory results would have been obtained. This practice is open, of course, to the objection that road dust may enter the crankcase. The application of continuous-oil-heating devices and oil-filters will contribute to the elimination or separation of water from the oil. Air-filters also have their place in this problem, as they will reduce piston and piston-ring wear and consequently assist them to maintain an effective seal and prevent a rapid increase in blow-by.

Nearly all of the measures that have been mentioned can be applied to existing equipment, as devices that are comparatively easy to install and that function satisfactorily are now manufactured and distributed as accessories.

It is realized that even a slight modification of engine design involves additional cost that is of importance to the manufacturer. The installation of various devices on cars that are now in the hands of owners is subject to a similar objection. The resulting satisfaction and assurance against trouble, however, would go a very long way indeed toward offsetting the additional expense that would be caused by such procedure.

Methods that can be employed to prevent condensation and accumulation of water in the crankcase are effective also in controlling oil dilution, which is no longer viewed with apathy. In addition, they will result in a more efficient utilization of fuel and oil and more satisfactory car operation in general.

CIVIL AVIATION

THE Department of Commerce and the American Engineering Council for some time past have gathered information relative to civil aviation. In June, 1925, a joint committee was formed to make a reliable comprehensive survey of the commercial and economic aspects of aviation throughout the world and to recommend the measures necessary to encourage a national development of commercial aviation in the United States. In the Committee's opinion the provision of essential air-navigation facilities is a public responsibility, a direct subsidy to civil aviation enterprises being unwise and unnecessary if these facilities are provided.

Legal Status and Control

(1) Congress enact a civil aeronautics law providing for
- (*a*) Establishment of a bureau of civil aeronautics in the Department of Commerce with power to
  - (1) Regulate civil air navigation in the United States
  - (2) License pilots and inspect and register aircraft
  - (3) Develop, establish or take over and maintain air routes and air navigation regulations as they affect the United States
  - (4) Administer international air navigation regulations as they affect the United States
  - (5) Encourage and promote civil air transport and the aircraft industry and trade
  - (6) Determine and impose civil penalties for violations of regulations
- (*b*) Recognition of the public right of free air navigation
- (*c*) Defining the liability of common carriers engaged in air transportation in interstate and foreign commerce
- (*d*) Reconciliation of the rules of water navigation with air navigation
- (*e*) Correlation of the laws relating to customs, public health, imports and exports, and other laws of general scope with the civil aeronautics law to recognize carriage of goods and passengers by air

(2) The several States enact statutes authorizing the municipalities to acquire and maintain with public funds, and to lease, landing-fields, and that for the present the other phases of state jurisdiction relative to aeronautics be permitted to develop under the common law

(3) The President submit to the Senate and that the Senate ratify with suitable reservations the International Air Navigation Convention which has been signed by representatives of the United States and ratified by most of the important countries except the United States

Government Program Regarding Civil and Industrial Uses of Aircraft

Also, the Committee recommended that

(1) The Government does not engage in non-military activities that can be properly performed by private operation

(2) The Government extend the use of aircraft in non-military Government activities where aircraft can be usefully employed, such as air-mail forest-patrol, agricultural, entomological and coast-guard services, aerial photography and map-making; the operations to be conducted by private agencies under contract wherever possible

(3) Under the legislation recommended, the Federal Government without delay provide air transportation with essential facilities such as lighted airways, emergency fields, maps, radio, and an adequate weather service

(4) Congress authorize the War and Navy, and other, Departments, to permit a reasonable use of Government landing-fields and ground facilities for commercial aircraft operations

(5) The Post Office Department actively encourage the establishment and extension of air-mail services and, as rapidly as it is possible to contract with responsible private operators, retire from the ownership and operation of such air-mail routes, turning over to the Bureau of Civil Aeronautics its airway equipment

(6) Under the direction of the President, the executive heads of the Departments concerned provide for the interdepartment coordination of all non-military Government air activities in order best to promote civil aviation

(7) Government purchases of aircraft be arranged to conform to a definite and continuous program that will give the greatest aid to the aircraft industry

(8) The Government carry on fundamental aeronautic research in the interest of civil aviation

(9) The Government not compete in the design, construction and major repair of civil aircraft, or handicap civil aviation by indiscriminate dumping of aeronautic material

(10) The Government adopt a policy of facilitating the exportation of commercial aircraft, thereby extending to the manufacturers a benefit that of necessity will result advantageously to the Government as the principal customer of the aircraft industry

Public and Business Support

Further recommendations of the Committee were that

(1) Aircraft underwriters base insurance rates to responsible aircraft operators on their record of performances, rather than upon average figures that include military hazards and the performance of irresponsible itinerate flyers

(2) Life and accident insurance companies reconsider the risks incident to specific types of flying, and modify accordingly their restrictions on aeronautic activities of policyholders

(3) Financial agencies and others invest in civil aviation enterprises only with full knowledge of the integrity and competence of all involved and careful scrutiny of the proposed financing, routes, equipment, depreciation rates, operating personnel, and probable character, sources and volume of traffic

Because of the lack of uniformity in state legislation and in the belief that the regulation of civil aviation is a function of the Federal government, the Conference of Commissions on Uniform State Laws has drafted and approved a uniform state law for aeronautics, without regulatory provisions. This legislation has been passed without change by Delaware, Nevada, North Dakota, Tennessee, Utah, and Vermont.

Michigan adopted the act, omitting the sections on uniformity of interpretation and the "short title." Hawaii adopted the act and added to it a section requiring a license for pilots and aircraft and a penalty for violation.

Indiana, Kansas, Pennsylvania, and Wisconsin have undertaken to encourage air transportation by enacting laws authorizing municipalities to acquire and maintain landing-fields. The Committee believes that this legislation is constructive in character and is a desirable field for state action.

Operations Abroad

A study of civil aviation reveals a number of significant facts of which the more important are briefly summarized below:

(1) No European air transportation company is self-supporting, though the proportion of earned income is rising rapidly on skillfully operated lines. The European Union, for example, in 1922 earned only 20 per cent of its total expenditures, while in 1925 it earned about 60 per cent

(2) The rates charged are not in general in economic relation to the actual operating expenses. Passenger rates as a rule are not much more than those for first-class railroad travel

(3) The regularity of service, particularly of departure and arrival on schedule time, is not yet up to railroad standards. This fact, coupled with the generally short length of the routes and the suspension of service in many instances during the winter months, is a serious drawback to the development of a permanent mail or goods air-traffic

(4) Air-mail traffic except on the line from southern France to North Africa has not developed as anticipated. The lack of night-flying, the relatively long interruptions to service during the winter months and the complicated relations between the many nations involved are the principal difficulties

(5) Night-flying is not as far advanced in Europe as in the United States Air-Mail Service

Operations in the United States

If civil aviation is to justify itself on a business basis in the United States we must supply air transport with those essential facilities that have long been accorded to surface transportation. The history of the railways, the waterways and the highways affords ample precedent. Federal appropriations during the current fiscal year for these purposes to waterway and highway transportation alone total about $200,000,000.

Until markets here and abroad for American commercial aircraft are further developed, the primary support of the aircraft industry must continue to come from the United States Government. This support should be specifically directed to assist the industry to establish itself upon a basis that will enable it to derive most of its business from the public and not from the Government. Such a condition can be hastened if the Government appropriate moderately for the design and experimental construction by private industry of commercial types of aircraft, engines and equipment for its non-military uses.

The aircraft industry cannot measurably benefit through Government orders in attaining a sound economic status unless such orders conform to a consistent and continuing production program. The failure to define and establish property rights in aircraft designs has discouraged private engineering initiative.

The present situation regarding aviation insurance in this Country is unsatisfactory. Coverage is not easily obtained and premiums for many types of insurance are practically prohibitive. Proper discrimination is not made between responsible and irresponsible operators. Insurance companies should grant to the careful operator rates based on his record for safety. Proper Government supervision, analogous in character to steamboat inspection, will improve air risks, as it improved marine risks.

The voiding of ordinary life-insurance during flight is a serious deterrent to the development of passenger travel in the United States. Insurance companies in a number of European countries have adopted a less restrictive policy. Similar action by insurance companies in the United States will tend to promote the development of air transportation.

Capital will re-enter the field only when it is assured that commercial aviation is recognized as a sound and growing business. Operations of the air mail and experience in this Country and abroad indicate that aviation offers a legitimate field for investment, but one that at this time is highly speculative. It is possible that some of the companies now entering commercial aviation, if well managed, may eventually develop good earning power.

STRENGTH OF WELDED TUBES[1]

THE tendency toward the use of welded steel tubes in the construction of airplane fuselages and the occurrence of several failures of such tubes in service have increased the importance of more adequate knowledge of the properties of welds in steel tubes. Many static tension-tests have demonstrated that low-carbon-steel tubes that have been butt-welded with the torch or the electric arc can be depended upon for a tensile-strength of at least 80 per cent of the original strength of the tube. However, the fuselage of an airplane is subjected to considerable vibration due to wind forces and engine vibration, and these vibrations set up rapid alternations of stress in all parts of the fuselage. Hence it is important to know something about the resistance of welded joints to repeated stresses and either to develop a means to overcome their detrimental effects or to supply the designer with reliable information as to what he may expect from a welded joint under such conditions of use.

With this in view, the engineering division of the Air Service is conducting an investigation of the resistance of welds to repeated stresses and is making tests by the rotating-beam method on a machine developed by the Division to handle tubes of 1-in. diameter. Tests so far conducted indicate that the resistance of either an arc or a torch weld to repeated flexural stresses is very low compared with that of the unwelded tube, as the endurance limit of both types of weld is not more than 14,000 lb. per sq. in., or only one-half of the endurance limit of the unwelded tube, which is 28,000 lb. per sq. in.

Location of the fractures of the specimens tested is of interest. In the static tension-tests the torch-welded specimen breaks at a point ½ to 1 in. from the weld, due no doubt to the softening of the metal of the tube at that place by the heat of the flame and also to the increased strength at the weld resulting from the extra thickness of the metal deposited there. In the repeated-stress tests, however, the fracture almost always occurs through the weld, which is evidently the weaker part of the specimen under repeated flexure. Fractures of arc-welded tubes occur at the edge of the weld in both static-tension and repeated-stress tests, as the heating is very much localized in this type of welding.

Further investigation is being made with a view to improving the strength of the welds by such methods as the application of heat-treatment, the use of different materials and the modification of the design of the welded joint.

[1] Abstract of an address made by R. R. Moore to representatives of the American Society of Mechanical Engineers and members of the Dayton Section at McCook Field, Dayton, Ohio. Mr. Moore is connected with the engineering division of the Air Service.

Tests of Carbon Deposition in Internal-Combustion Engines

By Donald R. Brooks[1]

Illustrated with Charts

ABSTRACT

METHODS adopted and results obtained in an investigation of the formation of carbon in an internal-combustion engine and its influence on the performance of the engine, as carried out by a series of tests, are described by the author. It was found that special methods of controlling the character and quantity of lubricating oil that reached the combustion-chamber were necessary to obtain concordant results on successive tests.

Four factors are believed to control the formation of carbon in an engine, namely, (*a*) quantity of oil that reaches the combustion-chamber, (*b*) quality of the oil, (*c*) rate of break-down of the oil in the chamber, and (*d*) time. Secondary factors are important only insofar as they influence these primary factors.

Certain substances are shown to accelerate or retard the rate of formation of carbon. Carbon is shown to increase materially the indicated thermal efficiency of an engine operating under conditions such that no detonation or preignition occurs. The increase of efficiency is found to be proportional to the weight of the carbon deposit.

CARBON formation in automotive engines has become a subject of increasing importance in recent years because of the progressively lowered quality of commercial gasoline. The gasoline of today has a much greater tendency to detonate than that used in former years. Moreover, it dilutes the crankcase oil, thus indirectly increasing the deposition of carbon. This carbon, acting probably as a heat insulator, results in conditions that favor detonation. Thus, in two ways the lowered quality of present-day gasoline has made carbon deposition a factor of economic importance in the operation of automotive engines.

Two classes of compounds for combating this lowered quality of fuel have been marketed. One class is asserted to suppress the detonation, the other class to prevent or remove carbon deposits. While some of those in the first class are of real value, tests show a large number to be worthless. Others, although of real value in suppressing detonation, are too costly to be of economic importance. Those in the second class, with very few exceptions, have been found to be worthless. Some have no effect on carbon deposition. Some even increase it. The regrettable conclusion from testing a number of such compounds is that they were produced and marketed without having been subjected to even a good road-test, much less to a conclusive laboratory-test.

This is not surprising after one has attempted to obtain concordant results on carbon formation in successive tests run under supposedly identical conditions. Of all engine-test measurements, that of the rate of formation of carbon presents the greatest difficulties. Factors that are negligible in other engine tests become of paramount importance in carbon tests, in which every factor that influences any phase of engine operation has some influence on the rate of formation of carbon.

The work of the Boyce & Veeder Dynamometer Laboratory, which was established primarily to produce a carbon preventive and remover, necessarily has consisted largely in the determination of the factors that influence the rate of formation of carbon deposits and of means of controlling engine operation so as to obtain concordant results in successive tests run under uniform conditions.

Preliminary Tests to Determine Factors Affecting Carbon Formation

Road-tests that were undertaken prior to the installation of this laboratory were of value only in indicating that, insofar as carbon-formation measurement was concerned, such tests were valueless and that only with the greatest care could such measurements be made accurately.

As both the Bureau of Standards[2] and the Bureau of Mines[3] had obtained very irregular and inconclusive results along this line of work, it was evident either that they had failed to control all of the factors influencing carbon deposition or that the deposition of carbon was very dependent upon a certain factor that was not controlled with sufficient constancy. It was decided, therefore, to design apparatus and equipment somewhat after that used in their tests but of greater accuracy and to seek to determine, by preliminary tests, the causes of the irregularities observed in the laboratories of the Bureaus.

The apparatus used consisted of Continental J-4 and Hupmobile R-12 engines, each coupled to Sprague dynamometers Type TLC-24. The fuel systems were gravimetric, giving a fuel flow regulated to 0.50 per cent and total fuel consumption measurable to within 0.05 lb. Valves suitably located in the cooling system provided control of jacket-water inlet and outlet temperatures. Oil-temperature control was afforded by a jacket in one case and by a coil in the other case, steam or cold water being passed through the jacket as required. Temperatures were measured by Moto-Meter industrial thermometers, as these had been found by test to be of satisfactory accuracy. Load and speed of the engine were measured by the dynamometer scales and by electric tachometers, which latter were of necessity frequently calibrated against the revolution counters.

Preliminary 2 and 4-hr. tests showed rather erratic results. It was noted, however, that whenever the cylinder-heads, upon being removed, showed oil above the pistons, the deposit of carbon in the cylinders was unusually large in quantity. Oil-scraping rings were then fitted carefully, in the belief that excessive oiling caused the irregular deposition. Tests made with these new rings showed a much smaller deposit, so small in fact that it was evident that the errors introduced in scraping would be an undoubtedly large percentage of the total error.

[1] Jun. S.A.E.—Research mechanical engineer, Boyce & Veeder Co., Long Island City, N. Y.

[2] See The Journal, December, 1924, p. 472.

[3] See Bureau of Mines Reports of Investigations, Serial 2517.

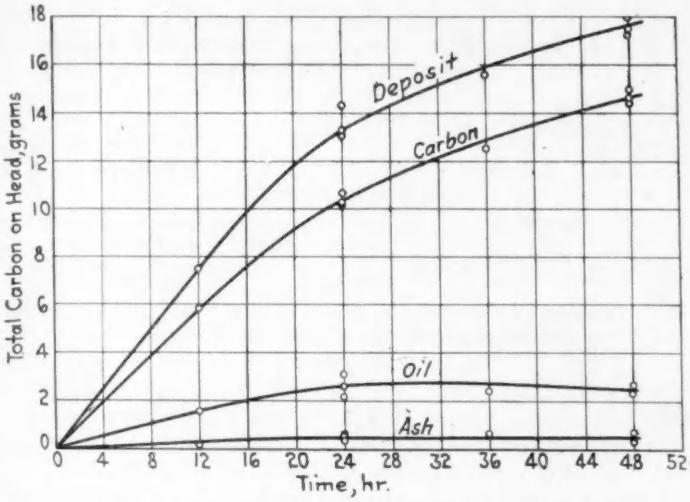

FIG. 1—TIME-RATE OF FORMATION OF CARBON DEPOSIT
The Test Run Was Made with a Continental J-4 Engine Operating on an Air-Fuel Ratio of 12 to 1 with Standard Gasoline to Which 1 Per Cent of Lubricating Oil Was Added. The Curves for Total Deposit and for Carbon Became Less After About 20 Hr. of Operation, and Examination of the Cylinder-Head Showed That This Is the Time at Which Flaking-Off of the Deposit Begins. As Flaking-Off Becomes More Pronounced, the Deposition and Flaking Tend Toward an Equilibrium and After a Long Period the Weight of the Deposit Ceases To Increase

From Bureau of Standards tests[4] it was known that a richer fuel mixture or a longer duration of operation would increase the carbon deposition. Upon trying a mixture 50 per cent enriched, a larger amount of carbon deposit was obtained, but results secured under these conditions on repeat tests were not satisfactory.

Lengthening the duration of the test also failed to eradicate the irregularities, hence the chemical character and viscosity of the oil were next considered as possible sources of the trouble. In spite of the preheating of the oil and the jacket-water prior to starting each test, it was found that the viscosity of the oil declined sharply during the first part of the test and less rapidly later. At this time, each test was being started with fresh oil in the crankcase.

Carbon Due To Oil in Combustion-Chamber

A new procedure was then initiated with the object of maintaining the viscosity and character of the oil more nearly constant. Several times during each test a sample of oil was taken from the crankcase and its viscosity determined immediately. An empirical chart, previously prepared, gave for various viscosities the quantity of fresh oil required to restore the viscosity of the oil in the crankcase to a standard value. Used oil was then withdrawn from the crankcase in such an amount that the addition of the required quantity of fresh oil filled the crankcase to its original level. This procedure resulted in more accurately controlling three factors, (*a*) the oil level, (*b*) viscosity of the oil and (*c*) its chemical and physical character. This last follows from the fact that any such system of partial withdrawal and replacement results in approximate equilibrium.

At this time, 12-hr. non-stop tests were inaugurated. As a result of most carefully fitting two oil-scraping and two regular rings to each piston, the oil-pumping, shown by test with the engine being turned over with the head off, was reduced to a minimum far below average. The deposition was not sufficient after 12 hr. to be measured accurately.

From the foregoing it was evident that the oil which reached the combustion-chamber was responsible for practically all of the carbon. All other factors, then, influence the deposition only insofar as they vary the quantity of oil reaching the combustion-chamber, its character or its rate of break-down in the combustion-chamber. This realized, it was seen that a constant supply of oil to the combustion-chamber would not only result in increasing the deposit to an amount more easily measured, but would smooth out such irregularities in the oil-pumping as seemed to occur spasmodically. Such a constant oil-supply was obtained by adding to the fuel 1 per cent of its weight of lubricating oil.

It is realized clearly that such a procedure could not be applied if a comparison were to be made between the rates of formation of carbon under conditions that normally gave differing rates of oil-pumping. For example, it could not be used in a comparison of carbon formation at different speeds, loads or mixture-ratios. However, for study of the time-rate of formation of carbon and of the influences of various preparations upon the rate of formation, it is believed that this procedure was fully warranted.

TABLE 1—RESULTS OF TWO SETS OF TESTS WITH OIL LEVEL, VISCOSITY, AND CHEMICAL AND PHYSICAL CHARACTER MAINTAINED

Test No.	Duration of Test, Hr.	Deposit, Grams	True Carbon, Grams
164	48	17.45	14.47
168	48	17.25	14.52
179	48	18.01	14.98
	Mean	17.57	14.66
174	24	13.09	10.29
212	24	14.31	10.63
240	24	16.17[a]	13.64
244	24	13.89[a]	11.38
248	24	13.14	10.19
	Mean[b]	13.51	10.37

[a] Piston rings subsequently found to be worn badly.
[b] Tests Nos. 240 and 244 omitted.

Results under this procedure were duplicated on repeat tests with satisfactory accuracy, as shown in Table 1. It is to be emphasized that these results were obtained, not on successive tests, but over a period of months. The mean error of the two sets of observations shown, disregarding those made with poor rings, is 2 per cent, which is well within the limit of 5 per cent that was set

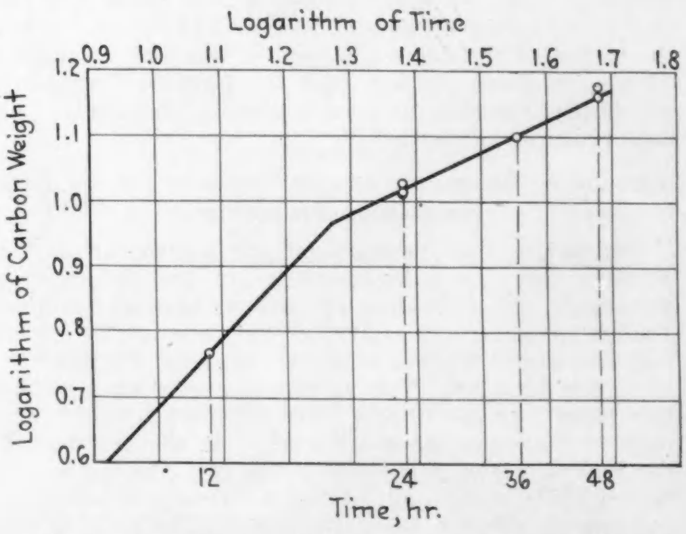

FIG. 2—CARBON FORMATION SHOWN ON LOGARITHMIC SCALE
This Projection of the Carbon Curve of Fig. 1 Shows More Clearly the Time Point at Which the Rate of Deposition Begins To Decline. It Is at about 19 Hr.

[4] See American Petroleum Institute Bulletin No. 73.

originally. This procedure was, therefore, adopted as standard and was used on all subsequent tests except those of very long duration.

Time-Rate of Formation of Carbon

For the purpose of studying the time-rate of formation of carbon, a series of tests of from 12 to 48-hr. duration was made under the following conditions: engine load, three-fourths; engine speed, 1200 r.p.m.; fuel mixture, 30 per cent rich; jacket-water inlet temperature, 150 deg. fahr.; jacket-water outlet temperature, 180 deg. fahr.; crankcase-oil temperature, 150 deg. fahr.; crankcase-oil viscosity, 200 Saybolt sec.; inlet-air temperature, 70 deg. fahr.; spark-advance, optimum; fuel, Standard gasoline containing 1 per cent of lubricating oil.

Results of these tests are shown in Fig. 1, in which the upper curve represents the total deposit, whose quantity was determined by weighing the material scraped from the cylinder-head. The weight of oil contained in the deposit was obtained by extraction with Eimer & Amend low-boiling benzine having a constant boiling-point of 177 deg. fahr. The oil-free deposit then was ignited in an open crucible, the loss of weight reported as carbon and the residue as ash. The three lower curves in Fig. 1 give these results.

It will be noted that the slopes of the Carbon and Deposit curves become less at approximately the 20-hr. line. This can be seen more readily on Fig. 2, which is the Carbon curve of Fig. 1 replotted to logarithmic scale and on which this point of change of slope is more definite and is at about 19 hr.

Examination of the cylinder-head showed that this is the approximate time at which "flaking," or mechanical loss of the deposit by cracking-off, begins. As this flaking becomes more pronounced, deposition and flaking probably tend toward equilibrium, that is, after a long period of engine operation the weight of the deposit practically ceases to increase.[5] Although the data at hand are too meager to allow of mathematical proof of this, that is, it cannot be demonstrated that the carbon weight would approach a definite value, yet to all practical purposes it is evident that an equilibrium weight is reached which is dependent upon the conditions of operation. Thus, in one case, with a lean mixture and a light load, 607 hr. of operation produced 7.79 grams of carbon, whereas, under heavier load and with a richer mixture, 150 hr. of operation gave 22.35 grams of carbon. While in each case the deposit of carbon was still increasing slowly, it seems evident that the light-load operation would never produce as much carbon as the heavier load had produced in 150 hr.

Effects of Character and Quantity of Oil on Rate of Carbon Formation

If it is true that the character and quantity of oil that reaches the combustion-chamber are the determining factors in the formation of carbon, then any radical change in either the character or the quantity of oil supplied should produce a radical change in the quantity of carbon deposited. Two experiments were made to test this belief. In the first, a standard lubricating oil was used in the crankcase in each test. In the first test, 1 per cent of this oil was added to the fuel. In the second test, a white mineral-oil, having a viscosity of 150 Saybolt sec. at 130 deg. fahr., was used in the fuel instead of the standard lubricating oil. In the second experiment, the white mineral-oil was used both in the fuel and in the crankcase for comparison with the standard lubricating oil. Results of these tests are given in Table 2.

TABLE 2—COMPARATIVE RESULTS WITH LUBRICATING OIL AND WHITE MINERAL-OIL

Crankcase Oil	Lubricating	Lubricating	Lubricating	Mineral
Oil in Fuel, 1 Per Cent	Lubricating	Mineral	Lubricating	Mineral
Duration of Test, hr.	24	25	20	20
Total Deposit, grams	14.31	7.99	6.62	1.71
Carbon, grams	10.63	6.63	5.58	1.12
Oil, grams	3.12	1.12	0.66	0.03
Oil, per cent	21.80	13.90	9.60	1.60
Ash, grams	0.56	0.24	0.38	0.56
Ash, per cent	3.90	3.00	5.50	32.80

These tests show clearly the effect of character of the oil on the formation of carbon. This, however, was a rather extreme case, as the Conradson value for the lubricating oil was 0.153 while that for the mineral oil was 0.006. In the first set of tests, changing the type of oil used in the fuel reduced the carbon by 40 per cent; in the second set, changing the type of oil used both in the fuel and in the crankcase reduced the carbon by 80 per cent.

The volume of oil supplied has been shown by other laboratories to be a large factor in the rate of deposition of carbon. No experiments have been made in the Boyce & Veeder laboratory in which the oil supply has been measured. However, upon filling the crankcase so full as to cause splash-feed as well as force-feed, a deposition of 2.22 grams of carbon was obtained in 20 min., whereas, under normal conditions, 9-hr. operation was required to form a like quantity of carbon. A further illustration may be cited from tests. When operating on gasoline alone, 2.96 grams of carbon formed in 20 hr.; when the fuel contained 1 per cent of lubricating oil, 5.58 grams of carbon formed in 20 hr.

Influence of Other Factors Negligible

From a consideration of these facts together with those given in Table 2, it is evident that the influence of factors other than oil character and supply is negligible, except insofar as these other factors influence the character and supply of oil or its rate of break-down in the combustion-chamber. Since the tests that furnished the data given in Table 2 were run with a mixture 30 per cent richer than that giving maximum power, it is evident that the carbon which may be attributed to the fuel itself is certainly less than 10 per cent of the normal total quantity of carbon. Indeed, certain tests that are not here presented indicate that the carbon which may be attributed to the fuel is less than 2 per cent of the total. Hence it may be stated as proved, that engine factors influence the formation of carbon only insofar as they influence either the character and quantity of oil supply or the temperature in the region of decomposition of the oil. Rich mixtures result in the formation of much more deposit than do lean mixtures, because the unvaporized fuel that is present in the rich mixture dilutes the cylinder-wall oil-film and results in increasing the quantity of oil that reaches the combustion-chamber.

Certain substances, when introduced into the combustion-chamber either in solution in the fuel or in the lubricating oil, have the property of changing the quantity of the deposit and, in a majority of cases, its composition as well. Table 3 gives results of tests made

[5] See *Journal of Industrial and Engineering Chemistry*, July, 1925, p. 731.

TABLE 3—CARBON DEPOSITS OBTAINED WHEN METALLIC AND ORGANIC ANTI-DETONATION SUBSTANCES THAT INCREASE THE DEPOSIT AND ALTER ITS COMPOSITION ARE ADDED TO FUEL OR OIL

Test Run No.	Test Duration, Hr.	Total Deposit, Grams	Carbon, Grams	Oil, Per Cent	Ash, Per Cent
1	24	13.09	10.65	16.5	4.9
2	24	32.38	21.98	6.1	25.5
3	24	22.85	17.16	14.4	10.6
4	24	15.06	12.12	14.0	5.3
5	24	23.64	14.80	11.2	25.2

with those substances that increase the deposit. The first run is the standard for comparison. The second run was made with 0.1 per cent of a well-known anti-detonation agent in the fuel. In addition to leaving a high percentage of inorganic salt as ash, it in some way doubled the formation of true carbon. This seems to be a characteristic of substances containing metallic compounds, as evidenced by run No. 5, also made with 0.1 per cent of a metallic compound in the fuel. Runs Nos. 3 and 4 were made with 0.5 per cent and 1 per cent respectively of organic compounds in the fuel.

Relatively few compounds have been found that diminish either the total deposit or the amount of carbon. One such compound, which is marketed extensively as a carbon remover, has a somewhat delayed effect, since it acts by accelerating the flaking process, previously mentioned. This action does not become marked until after

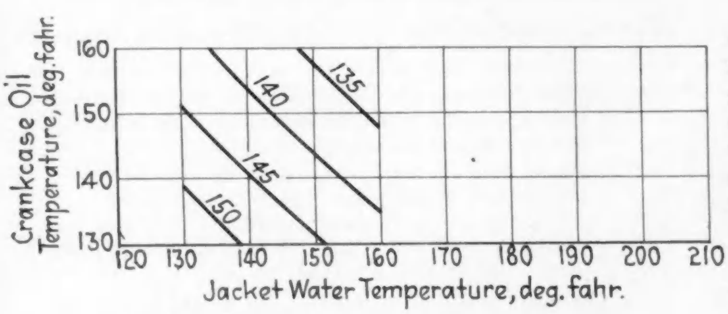

FIG. 3—EFFECT OF WATER AND OIL TEMPERATURES
This Chart Shows the Variation of Engine Friction-Torque at 1200 R.P.M. with Relation to Changes in Temperature of the Jacket-Water and the Lubricating Oil and Was Used for Correcting Results of Tests To Determine the Influence of Carbon upon Engine Efficiency When Conditions Were Such That Detonation Did Not Occur

24-hr. operation, under these test conditions. Under service conditions, however, the alternate heating and cooling should shorten this time.

EFFECTS OF CARBON ON ENGINE PERFORMANCE

The general effects of carbon in the engine are too well known to need detailed discussion. By inducing detonation, it results in overheating, loss of efficiency and loss of power when power is most needed, as in climbing a long hill. To avoid this detonation, compression-ratios must be kept low, resulting in continuous lowered efficiency. In short, carbon has been painted as black as it looks.

Little discussion has been had and apparently no thorough investigation has been made of the influence of carbon upon engine efficiency when conditions are such that no detonation occurs. A single test made in connection with tests of a fuel improver indicated that, at light loads, engine efficiency was improved by a carbon deposit. It was found possible to run a thorough investigation on this subject in parallel with another test at the Springfield laboratory. This investigation was made on a four-cylinder Hupmobile engine. Test conditions were: engine speed, 1200 r.p.m.; engine load, 30 lb. at 15.75 in.; carbureter-air temperature, 70 to 80 deg. fahr.; jacket-water inlet temperature, 150 deg. fahr.; jacket-water outlet temperature, 180 deg. fahr.; crankcase-oil temperature, 150 deg. fahr.; oil viscosity, 150 Saybolt sec., and spark-advance, optimum. These conditions were maintained as nearly as possible when making a test.

With the carbureter set to give maximum efficiency, nearly full lean, the time required for the engine to consume 0.25 lb. of fuel was measured. The carbureter

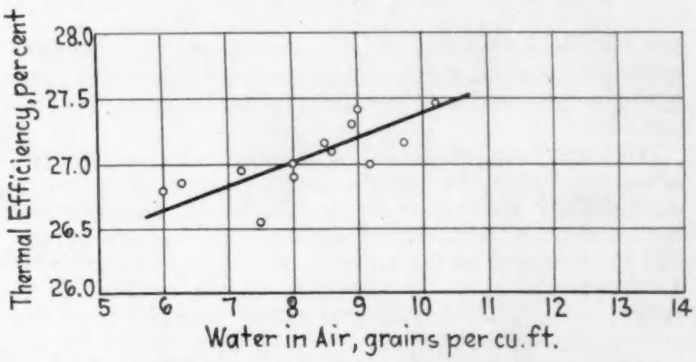

FIG. 4—EFFECT OF HUMIDITY ON THERMAL EFFICIENCY
Results Obtained from a Series of Observations Made Under Conditions of Nearly Equal Carbon Deposition Were Plotted against Absolute Humidity of the Air, and from This Curve All Results of the Test Were Corrected to a Standard Average Humidity of 8 Grains of Water Per Cu. Ft. of Air

was then set one notch for a richer or leaner mixture, the throttle adjusted to maintain the load, the spark reset to optimum, and another fuel-time taken. This was continued until at least two observations were obtained with richer and two with leaner mixtures than that giving maximum fuel-time. Table 4 gives the results of a sample test.

Results thus obtained were corrected for such variations as occurred in water and oil temperatures, by means of a chart, Fig. 3. These results were then plotted against the carbureter setting or, preferably, against

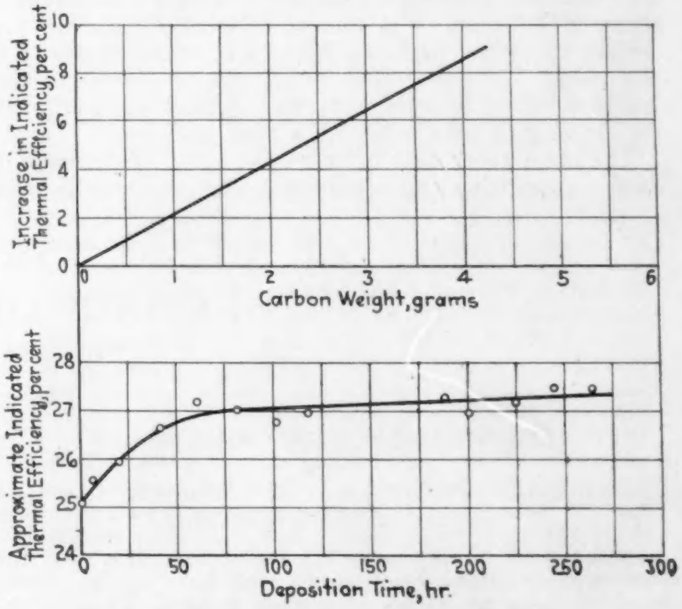

FIG. 5—EFFECT OF CARBON ON THERMAL EFFICIENCY
These Curves Show Definitely That an Increase in Thermal Efficiency Accompanies an Increase in Carbon Deposit. Carbon Deposited in 100-Hr. Operation Caused an 8-Per Cent Gain in Indicated Thermal Efficiency over a Clean Engine. The Fact That the Upper Curve Plotted against Weight of Carbon Deposit, in Grams, Is a Straight Line Indicates That the Carbon Acts Solely as a Heat Insulator in Increasing the Thermal Efficiency

TABLE 4—SPECIMEN OF TEST TO DETERMINE EFFECT OF CARBON DEPOSITION ON THERMAL EFFICIENCY OF ENGINE

Carbureter Adjustment	Fuel-Time,[a] Sec.	Temperature, Deg. Fahr. Jacket Water Inlet	Water Outlet	Oil	Air	Humidity, Per Cent	Manifold Vacuum, In.	Water in Air, Grams per Cu. Ft.
0	133.6	151	183	145	88.5	51	11.70	7.3
1	136.1	150	181	145	88.5	51	11.15	7.3
2	135.2	150	180	145	88.5	50	10.60	7.2
2	134.3	150	180	145	87.5	50	10.55	7.1
1	135.8	150	181	145	87.5	50	11.25	7.1
0	133.5	151	182	145	88.0	50	11.70	7.1
1	134.8	151	182	145	87.5	50	11.25	7.1

[a] For consumption of 0.25 lb. of fuel.

the manifold vacuum, and the maximum fuel-time was inferred from the curve. In no case did this differ from that obtained in the actual observation by more than 0.5 per cent.

Humidity was suspected of having some effect upon efficiency, hence the results obtained from a series of observations made under conditions of nearly equal carbon deposit were plotted against the absolute humidity, as expressed in the units in the last column of Table 4. From the curve so obtained, shown in Fig. 4, all results were corrected to a standard average humidity of 8 grains of water per cu. ft. of air. These corrections were slight, rarely more than 1 per cent. The corresponding indicated thermal efficiencies were then computed from these corrected results.

Carbon Deposit Increases Thermal Efficiency

During these tests the engine was running under constant conditions 20 hr. a day, hence the total elapsed time was a convenient measure of the rate of carbon formation. The indicated thermal efficiencies, shown in the lower curve in Fig. 5, were therefore plotted against elapsed time. This curve shows very definitely that an increase in efficiency accompanies an increase in carbon deposit. Under these conditions the carbon deposited in 100-hr. operation caused a gain in indicated thermal efficiency of 8 per cent over that of a clean engine.

From other tests the rate of carbon deposition was known for periods up to 600 hr. The gain in indicated thermal efficiency was therefore plotted against the weight of carbon deposit. The upper curve in Fig. 5 is the result. The fact that this curve is a straight line indicates that, in increasing the thermal efficiency, the carbon deposit acts solely as a heat insulator.

The close agreement between the rates of increase of carbon deposition and of thermal efficiency may best be shown by expressing each by an equation of the form $y = ax^b$, where x represents the elapsed time. Such an equation, fitting the efficiency observations with a mean error of 0.26 per cent, has for the exponent b the value of 0.342.

Applying the same type of equation to the carbon-deposition data, we obtain for b the value of 0.347. This latter equation fits the carbon-deposition data with a mean error of 0.18 grams. Since both equations fit the data within the limits of experimental error, and since they both contain time to the same power, it is evident that the efficiency increase bears a truly linear relation to the carbon increase.

It is true, naturally, that the carbon deposit increases the compression-ratio to a slight extent. However, in terms of thermal efficiency, the maximum effect in this investigation is computed to be of the order of 0.1 per cent and hence is negligible. This effect of carbon is of sufficient magnitude to be noticeable in the operation of an automobile. It may be verified qualitatively as follows: Just before scraping carbon, adjust the carbureter so that when starting "cold" it is necessary to use the choke for a few minutes. Scrape the carbon, then attempt to start as before. It will be found that starting is much more difficult and that a longer use of the choke is required. This presupposes, of course, that weather conditions have not changed materially in the interim.

Conclusions Deduced from the Tests

The following is believed to be indicated by the tests as fact:

(1) Carbon formed in internal-combustion engines arises from thermal decomposition and oxidation of the lubricating oil

(2) Factors that influence the rate of deposition of carbon are those which affect the quantity and character of the lubricating oil that reaches the combustion-chamber and its rate of break-down in the combustion-chamber

(3) The total quantity of carbon that would be formed in unlimited time is dependent upon the conditions of engine operation

(4) An increase in carbon deposit increases the indicated thermal efficiency of an engine and the gain in efficiency is proportional to the increase in the carbon deposit

(5) An increase in absolute humidity in the air-fuel mixture appears to increase the indicated thermal efficiency of an engine

MEETINGS OF THE SOCIETY

(*Concluded from p. 40*)

SPLENDID SECTION MEETINGS

Commendable Performance of Numerous Sections Strengthens Society's Value

In the work of the Society it is certainly true that the success of its various Sections is a vital factor in the esteem in which the organization as a whole is held. Through various technical meetings the Sections this year have created an enviable record that is to be highly commended. In the last month a number of events of importance have been arranged and staged by the local organizations that are deserving of extensive recognition. The plans for future meetings also promise well.

An event that will be of peculiar interest to all Sections is that planned for Monday evening of Show Week by the Metropolitan Section. Preceded by a dinner at Hotel Commodore to which all Section members are invited, a meeting will be staged at the same hotel, at which many chief engineers and important officials of various motor-car companies will announce the interesting developments in their product that will be on display at the New York City Show. The Metropolitan Section has displayed its hospitality by cordially inviting members of all Sections to participate in this undertaking. Announcements have been circulated and additional details may be obtained by addressing Mr. F. K. Glynn, New York Telephone Co., 15 Dey Street, New York City.

Discussion of Papers at Production Meeting

THE discussion following the presentation of four of the papers at the Production Meeting of the Society held at Cleveland last September is printed herewith. The authors were afforded an opportunity to submit written replies to points made in the discussion of their papers and the various discussers were given an opportunity to approve the stenographic report of their remarks before publication.

For the convenience of the members brief abstracts of the papers by Mrs. Lillian M. Gilbreth, Louis Ruthenburg and G. F. Keyes precede the discussion of these papers with a reference to the issue of THE JOURNAL in which they appeared so that members who desire to refer to the complete text as originally printed and the illustrations that appeared in connection therewith can do so with the minimum of effort. The other paper for which discussion is printed, that by F. T. Jones, will be found on p. 60 of this issue of THE JOURNAL.

TRAINING EMPLOYES IN PRODUCTION WORK

BY LILLIAN M. GILBRETH[1]

ABSTRACT

SUCCESSFUL production demands the greatest amount of output with the least amount of effort. It is of prime importance in industry, and its slogan is the elimination of waste, considering always the worker, surroundings, equipment and tools and the methods or motions used. Therefore, it is necessary to give attention to training employes in production work. The paper evaluates training in terms of production and formulates the elements that have proved effective, the aims of such training being to develop a better worker in the particular job, to produce a better member of industry and to create a better member of society.

The worker always must be judged with relation to his work, and no more important psychological test exists than that of aptitude for the job. The surroundings, equipment and tools warrant intensive study, but great care must be taken to avoid duplication of work already done and to make use of the advice of experts regarding heating, ventilating, fatigue and posture. The chief emphasis must be placed on methods or motions used, and these must be carefully investigated, standardized, and taught, considering the factors of teaching under the headings *what* is to be taught and *who* is to teach it; and *when*, *where*, *how* and *why* it is to be taught.

The "*what* is to be taught" includes consideration of the problem of industry itself, of the plant and of the department in which the worker is, of the operations that he performs and the like. It involves a study of both the aptitude and the handicaps of the learner, and covers Fatigue Study, Motion Study and Skill Study. The method of attack includes the elimination of motions and fatigue, the simplification of methods, the standardization of accepted practice and the maintenance of the "one best way" that has been standardized.

Transference of skill is the primary concern of the teaching, which considers constantly the "therbligs" or elements of motions that are the units by which skill is measured. Teaching can be done by any worker, although this is seldom profitable because the worker may have no training in teaching and has seldom an incentive to teach. It can be done by the foreman, who has both time and incentive, but is seldom trained. It can be done profitably by a training department, through supplementary courses or by an expert who understands both teaching and the work to be taught.

Training should not be confined to any one period. It should start in the employment department, with the selection of the worker and making him acquainted with the work he is to do. It should continue through the training period and through constant follow-up during the entire life of the worker in the industry. Meetings, both within and without the organization, assist in the training and are a valuable stimulus. A certain amount of training can be done profitably in the laboratory or department of training, but much must be done at the workplace itself, under the actual working conditions and with the working incentives. This is so important that teachers should themselves be retrained at stated intervals under plant working-conditions to make sure that the instructions meet the actual practical needs.

Every possible vehicle of instruction should be used; the eyes, the ears, and the motor senses should be trained. Both the micromotion and cyclegraph methods appeal to many senses and build up an adequate learning process. Fatigue always must be considered in all training. Eye fatigue must especially be avoided by blindfold teaching and by using the hearing and other senses whenever possible. Great emphasis must be laid on teaching the learner to think in terms of motions and elements of motions. This is the most valuable result of the type of training here advocated, and is a specific means of evaluating training for production.

It is because of the importance of the transference of skill that teaching is such a vital element of efficient production. None but the best teaching is suited to industrial needs. Progress along this line in the last 10 years is most encouraging and, instead of tracing the effects of education in schools and colleges upon industrial education, we may expect to find marked traces of the effects of training in industry upon school practice.

The result of the teaching here advocated is a definite increase in training in industry. Illustrations of the applications of the methods outlined in various industrial fields, especially in the automotive industry, prove that output can be increased many times through efficient teaching. While these results show the needs of other factors in scientific management besides teaching, they never could have been attained without the teaching, no matter what the changes in working conditions. Further, while efficiency from the motion-study standpoint is not the only test of efficiency of teaching for production work, such teaching does make possible the evaluation of existing practice, which is the first step in progress. [Printed in the October, 1925, issue of THE JOURNAL.]

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TRAINING THE FOREMEN OF A MANUFACTURING ORGANIZATION

BY LOUIS RUTHENBURG[2]

INDUSTRIAL development has out-run foreman development, in the author's opinion. He believes that management should be alive to the changed status of the foreman and that it should train him definitely to accept a broader responsibility. Clarification of the situation should start with the assumption that the departmental foreman is to be held definitely responsible for every activity that affects his department; but, obviously, he cannot be given direct authority over certain functionalized services that very directly affect the operation of his department, and he must, therefore, develop that higher type of executive ability which can obtain results without the club of direct authority. In short, instead of conceiving the departmental foreman as the master craftsman of his department, he should be looked upon as the business manager of his department.

Business management, even of a factory department, involves an understanding of many things that the foreman cannot learn thoroughly or systematically in his craftsmanship experience. Business problems usually involve one or more of three elements: technical, economic and the human. Foremen are usually most proficient in the first element and are deficient in the last two. Management generally does not recognize the desirability of training foremen in basic economic principles and in the elements of human reaction.

In planning a foreman-training program, method is initially of much greater importance than text matter. "*How*" should take precedence over "*what*." A receptive attitude on the part of the men to be trained is absolutely essential before training can be effective. Leadership acceptable to the men to be trained is another primary requisite. The training program should be actively sponsored by the highest official whom the foremen recognize as a practical manufacturing man.

Obviously, the lecturers or teachers employed in foreman training must be carefully selected. Their desirable qualifications are outlined, suggestions are made as to text material for a primary foreman-training course. The feasibility of advanced courses to follow the primary course is discussed, the results obtained by foreman training under widely varying conditions are pointed out, and the methods of foreman rating and promotion are touched upon. It is difficult to train men in foremanship after they have become foremen in name. Training should start among candidates for supervisory positions, and foreman apprenticeship is discussed in connection with the "Squad Idea." [Printed in the October, 1925, issue of THE JOURNAL.]

THE DISCUSSION

CHAIRMAN JOHN YOUNGER[3]:—I once participated in a practical demonstration of foreman training. I was very anxious to impress the foremen with the necessity of conserving material and reducing scrap. One day, during lunch hour, I walked past the spot where the foremen were gathered and, as I did so, I pulled out my handkerchief. Strange to say, out came a dollar bill and it fluttered to the floor. Every foreman immediately made a grab for that dollar bill. "Yes," I said to them, "you grab for that dollar bill, but if it were a piece of material you wouldn't turn hand or foot to pick it up." That had considerable effect on those foremen, and I think a practical demonstration like that does considerable good sometimes.

NORMAN G. SHIDLE[4]:—Several points in these papers impressed me particularly. One is the source from which men to conduct foreman-training work are to be obtained. I gathered from Mr. Jones' paper that a member of the organization's staff should not conduct such work because the foremen might look upon him with suspicion. Mr. Ruthenberg said that the teacher should be a representative of the organization, or that the chief executive of the organization should have a definite part in the training work. My feeling in the matter is that when the teacher is not a part of your own organization and is a man who comes in from the outside to attempt to convey the knowledge to your workmen, you are missing one of the broader opportunities of foreman training. After all, foreman training is not an end in itself; it is a means toward the end of getting better production, greater profits and lower cost of production. If the foreman in the plant looks upon the ideas coming from the executive with suspicion, I would say that something is wrong which is more basic than the need for foreman training. A plant cannot function effectively in any phase of work so long as suspicion exists between the foreman and the executive. In a specific instance in which that condition does exist, an outside man might be chosen, but that is a condition which would not be remedied by a superimposed course of training.

Foreman training should be a matter of the mutual exchange of ideas between the management and the foreman. It should be that rather than an attempt on the part of the management to propound preconceived notions, formulate orders and hand them to the foreman. The management of any organization should be able to derive great benefit from giving the training course by finding out *what* the foremen think and *how* they think. Not only is such information of great help to the management in its future dealings with the foremen, assuming that in certain respects the intention is to think as the foremen do, but it also is a great benefit to the foremen.

I am always suspicious of rushing to get some outsider to come into the plant. Three years ago a representative of a certain system, whereby a series of letters urging loyalty and fidelity was to be sent to the workmen in a plant by an outside company, threatened to sue me and the others of our company because I thought that was not a proper thing to do. I believed it a waste of money and that it was encroaching on the responsibilities of the management. I said to him, "You will sell this service to anybody, will you not?" He answered, "Yes, we will sell it to any reputable firm that will pay its bills." I asked him if he would sell it to a particular company which I named and he said, "Yes." I then questioned him as to what he knew about the company's shop conditions, whether he had made inquiries there to find out if any reason existed why the men in that plant should be satisfied and loyal or not, and he replied, "Well, we can't spend any time to find out." I told him that sounded foolish to me.

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[3] M.S.A.E.—Owner and editor, *Automotive Abstracts*, Cleveland.

[4] A.S.A.E.—Editor, *Automotive Industries*, Philadelphia.

In approaching a problem such as foreman training, it seems to me that the management must take the initiative and do the job; but, on the other hand, the management should watch very carefully and try to get the foremen's and the workers' points of view, so that they can be influenced to do what the management wants them to do, accomplishing this in a way that will make them want to do it and thus making it less likely that training will be forced upon them.

I can illustrate my point best by comparing the novel and the essay. The shortest form for expressing a complete idea in writing is the essay. Let us take, for instance, two works by H. G. Wells, one called The Soul of a Bishop and the other, God the Invisible King. The latter conveys in 100 pp. exactly the same idea as does the former. One can be read much more quickly than the other, but many people do not like it in essay form because they do not react that way and like to get it in the easier to read novel form. One can say, "They ought to want it presented as efficiently as possible," but one has to find out what they want and give it to them in a way that is attractive to them. If you think of yourself as being in a similar position, you find that you read the magazines, the newspapers and books that interest you. Perhaps they are not the ones you should read and they may not give you what you should have, but they are the most satisfactory to you. You must understand the other man's point of view and in no instance is that more important than in the case of foreman training.

CHAIRMAN YOUNGER:—All the speakers have commented on the fact that, in training people, one must use simple language.

L. W. WALLACE[5]:—In a paper I delivered about 10 years ago, I said that the foreman is the weakest link in the chain of industrial production. I felt that way strongly at the time and, although we have made some progress, I believe it is still true. When foreman training becomes more universal, the strength of the weak link will compare more favorably with the other links of the industrial chain.

I have had considerable contact with industry as an engineer and as an executive. In the light of my industrial background I feel that one of the most fundamental statements made at this meeting was contained in the utterance of Mr. Shidle. He said that something is fundamentally wrong in an organization if suspicion exists to such an extent that the executives of that organization cannot take charge of a foreman-training system and carry it out successfully. Parenthetically, more unrest and waste obtains in industry, due to suspicion, than to any other one factor. No sound reason can be given for the existence of suspicion and distrust in any industrial organization. No material distrust and suspicion would be found if industrial executives would daily strive to instill confidence in their employes. This can be done by practising the virtues of frankness, sincerity and fairness of purpose and dealing. If confidence be established foreman training will be easy and many of the complex personnel problems of the day will be eliminated. We should be so fair and so sympathetic that no matter what may be troubling our employes they will feel free to come to us, knowing that if they do they will receive a sympathetic and helpful hearing.

F. T. JONES[6]:—The comments of Mr. Shidle and Mr. Wallace show how careful one must be in presenting obvious although perhaps minor facts. In suggesting the advisability of making use of Smith-Hughes men in conducting foremen's conferences, I commented on the way in which the foreman looks at things saying—

> He is naturally suspicious when called into a production conference and told about a new policy or given instructions for changes within his department. He wonders what is being put over.
>
> He is inclined to put so-called "foreman training" in this category. In view of these facts executives in industry have done wisely to call in the Smith-Hughes men and have the latter carry on training by the conference method.

These men can command a degree of confidence rarely possessed by production executives within the company. Furthermore they know the technique of imparting information.

The statements of Mr. Wallace and Mr. Shidle indicate clearly that the 4 per cent of officers and owners is entirely uninformed about what the 84 per cent of wage earners is doing, as I brought out in my paper.[7] Go to your foremen and get their confidence. The statements made are correct; but, if you think you have the entire confidence of your men, look out, because I do not, and most officials do not, believe that you have it.

W. W. NICHOLS[8]:—Mrs. Gilbreth touched on a point that I think is one of the most important when executives are dealing with foremen and foremen with workmen; it relates to the *why* of it. If you get a group of foremen into conference and tell them that you want a certain thing done without giving a reason, and if afterward you ask them if they understand what you mean, they will answer "Yes." Then if you ask them individually to state their own viewpoint about it, nearly every one of them will differ from you and you will find that they have not understood your viewpoint at all. But if you take the time to explain why you want the work done in a certain manner, you will get much better results. If those foremen leave that conference and you have not explained fully why you want that thing done in a particular way and they go into the shop and do not do the work in the way in which you wanted them to do it, you censure them; but how can you expect to get cooperation under those conditions? You cannot, and you never will carry the crowd with you in that way. The foreman has to *lead* his men, not *drive* them.

Mr. Ruthenburg brought up the subject of the different departments with which the men come into contact, such as the managerial, the rate setting and the inspection departments. It often has occurred to me that, in training foremen, it would be a good thing to have the men serve a short time in each department and so get an idea as to just how the departments are operated. You have all heard them kick about the time-study department, or listened to their complaints about the tool designers and how they design tools that will not work. But if those men could work a short time in those departments, they would get an idea as to how the departments operate. I believe that would result in a better grade of foreman, who would get greater efficiency from his men.

CHAPIN HOSKINS[9]:—If Glenn Gardiner of the Oakland Motor Car Co. were here, he could tell you much from his experience that would bear on this question, but since he is not here, I will try to give you second hand some of the things he has told me. At one time, the General Motors organization had a property that was in bad shape and Mr. Gardiner was employed to help improve

[5] Executive secretary, American Engineering Council, City of Washington.

[6] Supervisor of training, White Motor Co., Cleveland.

[7] See p. 60.

[8] A.S.A.E.—Mechanical engineer, D. P. Brown & Co., Detroit.

[9] Managing editor, *Factory*, Chicago.

the labor conditions. At this time he shared in some very successful training that was carried on by men inside the organization.

Afterward, in cooperation with the University of Wisconsin, Mr. Gardiner carried on foremanship training in a number of other factories. In these cases, the training was by someone outside of the particular factory organization. Recently, because of his success both in training men inside the General Motors organization and in training foremen outside of it, the Oakland Motor Car Co. has hired him to train its foremen.

The fact that Mr. Gardiner has been successful in both types of training seems to show that whether or not the individual who trains foremen comes from outside the plant or inside depends entirely on the particular conditions in the factory. In a small organization whose executives cannot devote sufficient time to the training of foremen, or give enough time to become expert in the study of this problem, it may be better to get a teacher from the outside. But where someone on the inside can specialize on training foremen, it may be better to have an inside man.

ROSSITER R. POTTER[10]:—Whether to secure an outside teacher for foreman training or one from within the plant centers on the necessity of inducing receptiveness to the training on the part of the foreman. The process of causing men to acquire that spirit is known as salesmanship. Many of the executives in an organization are, probably, good organizers, but good organizers are very rarely good salesmen. This is one of the reasons that some men in certain organizations may fail to introduce a training system successfully, even with the help of the organization and with its cooperation, and why the teacher from the inside may fail.

From a somewhat similar viewpoint, it is poor salesmanship to allude to the possibility that the working men in the organization are suspicious of training that comes direct from the management. No management likes to be told that its men are suspicious of it, and I think it better to put the matter on the ground of inducing receptiveness. It is naturally necessary that a new and unfamiliar proposition must be "sold" to the workmen before we can expect them to give it an enthusiastic welcome.

LILLIAN M. GILBRETH:—All of you are right as to the question of who should take part in foreman training. Mr. Ruthenburg raised a splendid point with regard to the importance of having the proper person responsible for this work. With regard to the securing of the outside person, or having some one from the inside, why not use them both? You must get your foremen into the proper attitude of mind. You need to use psychology in this work of foreman training, and you must have the actual demonstration work to get the proper results, so it is necessary that you have some one who is able to do this demonstrating successfully.

When it comes to teaching, very few clever engineers know one thing about the teaching process. They do not know what a "learning process" is, who the "eye" people, and who the "ear" people are. The most capable teachers must be located and they must be shown that teaching must be done in the right way to put the process across.

CHAIRMAN YOUNGER:—Mrs. Gilbreth mentioned the necessity for getting the workers under training to work with you. I had the privilege at one time to hear Frank Gilbreth talk about that; he said that, to get the proper results from the training, you should get participation. In other words, the people you are working on should participate with you. It is similar to driving your automobile and having your youngster sit in the seat beside you. He wants to get his hand on the steering-wheel, for then he feels that he is doing something toward making the car go along. That is participation. People like to participate; I found that out in a peculiar way. During the war a certain instructor taught the men how to handle a rifle with the aid of moving pictures that illustrated the various ways in which to hold a rifle, how to clean it and the like. In one instance, when showing the pictures, one of the men called out, "That's wrong." The instructor asked what was wrong and was told. That gave a clue, and they immediately began making films that were wrong. Then the instructor would ask, "What is wrong with this?" The men would then explain what the trouble was and in that way they all would participate, in place of sitting there like dummies.

LOUIS RUTHENBURG:—Perhaps I can clarify my point of view toward this matter of leadership in foreman training. One of the greatest assets in an industrial organization is solidarity. For that reason, I would hesitate a long time about bringing in an outside teacher, except as an incidental contributor in the class work. I would not, under any circumstances, bring in an outside man to conduct the classes. Such procedure tends to destroy the solidarity of your organization. Suppose the foremen are suspicious of the management's motives. The obvious thing to do is to break-down that suspicion, for you cannot have the most effective foreman-training so long as it exists. If you take from 2 to 4 years in getting ready for foreman training, you have done a better job than if you rush into it half prepared, only to find that to complete a gesture you must hire some teacher from the outside, and give the men a training course when they are not prepared for it.

In my own experience I will admit frankly that at least 3 years was needed in one instance to break-down just the feeling which Mr. Jones spoke about, before we dared say anything about foreman training. In another instance, after 2 years we have not yet finished the necessary preparatory work and we have not said anything about definite training in that organization.

I think the management must have the proper viewpoint and that it must be sure to choose the proper person as the instructor, even though a long time is spent in finding the man to fill the job. But let him be one of your own men when he comes before the foremen; not a man from the outside who comes in to tell the men something that they will not accept from a member of your own organization. I think that is pernicious. We have never hesitated to bring an outside speaker in, but he always comes in under the auspices of our organization. That explains, as clearly as I know how, my point of view toward that particular phase of the subject.

MR. JONES:—I believe the difference of opinion is not serious. Mr. Ruthenburg himself says that if you have no suitable man in your organization to act as an instructor, bring one in. If things are not right in your organization so that you can provide an instructor yourselves, wait until they are right. I agree that you must adapt yourselves to the conditions that exist. Great emphasis has been placed upon the statement that the foreman is naturally suspicious. If you want to debate that question, I will win, if we take it out on facts and not on camouflage. Study your own organization; but, whatever you do, do not allow some one to do this fore-

[10] M.S.A.E.—Assistant to the president, Shakespeare Co., Kalamazoo, Mich.

man training if he does not know how to do it. I do not conduct the actual foremen's conferences myself, although I am always present, because I believe it not the best thing for a member of the management to try to do the initial foreman training. The men will be much freer in their expressions of opinion and help themselves and the management more by free discussion in the presence of the outsider. I believe that, and Mr. Ruthenburg believes the other way; but we can differ and remain friends.

CHAIRMAN YOUNGER:—And you both agree that it is the thing to install foreman training, either from the outside or the inside. The problem is, to do it.

MR. RUTHENBURG:—I agree with Mr. Jones that you often find suspicion of the management's motives on the part of the foremen but, in Mr. Jones' opinion, is it not possible to remove the suspicion and make the foremen component parts of the management?

MR. JONES:—That is a tough question to answer. It can be done by showing that the interests of the men and the management are mutual. That takes time and the time can be shortened by starting your foremen's conferences with the assistance of outside men. If it is possible to do it with your own men, anything is possible. Is it practicable? I doubt if it is, and doubt that it conforms with human nature to expect it.

HOT STAMPINGS AND THEIR PRODUCTION

BY G. F. KEYES[11]

ABSTRACT

WHEN production is on a small scale or when it is necessary to get into production in a very short time, the making of sheet-metal fenders, body panels and other stampings by the hot-stamping process is to be considered, as it is possible by this process to make very difficult stampings in less time and at considerably less cost for the dies than by the cold-stamping method. Moreover, the hot stamping is a better product than the cold stamping, as it follows faithfully every contour of the die and retains its shape, having no tendency to "spring back" from form. The skill and perfection attained in the hot-stamping process are the results of more than half a century of development, outstanding examples of which are heroic-size statues on public and corporation buildings and in municipal parks. With the advent of the automobile, the skill of the artisans was turned to automotive sheet-metal work.

Dies for hot stamping are made of semi-steel castings with their faces built-up of a number of "pick-up" forms about 1 in. thick made of lead hardened with antimony, which are cast in molds made from wood or plaster-of-paris models. From three to seven "breaking-down" operations are usually required for producing the finished stamping without wrinkles, buckles or other defects. The "pick-ups" for these several operations are built-up on the face of the lower die and each "pick-up" represents one drawing operation. After each operation, one "pick-up" is removed from the lower die and attached to the upper die. These operations are performed on cold sheets. In the final operation the stampings are heated cherry red and run through the press under a lead die faced with a heavy-gage stamping lined with asbestos. After cooling, the stampings are run through the die with irons attached to sharpen all corners, to set beads and to take out shrinkage caused by cooling. [Printed in the November, 1925, issue of THE JOURNAL.]

THE DISCUSSION

MR. KEYES:—I may explain further, with regard to making the pick-ups, that the surface of the die for an ordinary fender, for example, that has possibly a 3 or 4-in. draw, would be built up by layers of lead from ½ to ¾ in. thick. These pick-ups represent the number of operations that would be required to draw the stamping down and, as it is usually worked out, the pick-ups are so arranged that the stamping can be drawn down to the approximate shape of the final die without a hot operation. A hot operation follows after all of the pick-ups have been taken-up and fastened to the upper die. The pick-ups are attached to the upper die by small pieces of sheet steel that are formed into little curls. Each piece of steel is about ½-in. wide and is formed into a curl about ¾ in. in diameter. These pieces are equally spaced over the top of the pick-up and the lead die is dropped, if a drop hammer is used, or pressed if it is in a double-action or a single-action press, and the contact attaches the pick-up to the upper die.

In the hot-stamping operation the press is brought down on center and held there for a short time until the stamping is set. Then it is turned over and when the stamping is taken out it is practically set to the final shape. A certain amount of shrinkage occurs after the stampings come out of the press following the hot run, and for that reason they are run again, but in many cases corners or beads have to be drawn out to a sharp shape. On wheel housings, for example, the corner of the stamping must be sharpened up.

A very difficult stamping can be made by the hot-stamping process and the result is practically certain the first time the die is placed in the press, because considerably more can be done by working metal hot than by working it cold. Ordinarily, when a cold-drawing die goes in a press, whether it is for a tonneau, back or upper-back panel, it will be days and sometimes possibly 2 weeks before the final stampings are obtained, but, with the hot process, the occasions are very few when a perfect stamping is not made the first time the die goes on the press. This, of course, saves time in getting into production.

I will cite one specific case in which hot stampings were used to advantage. An automobile company that brought out a roadster model had no way of knowing how strong the demand for it would be and for that reason made no provision for a heavy production schedule, but as soon as the new roadster was seen by the public it was very much in demand. The company could not take care of the required production with its bumping-out process. It needed immediate relief and we suggested making the stampings hot, by which process we could furnish the finished stampings inside of 6 weeks. The company went ahead with that process but the demand became so great that it was necessary to turn from hot to cold stamping to take care of the production. The hot-stamping process filled the gap between the time the company stopped making bumped panels until the cold drawing tools were finished. As I have said, the hot stampings are not for large production, the process is employed to take care of the small-production jobs. Hot stampings represent possibly

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about 5 per cent of our total business at the present time.

L. L. WILLIAMS[12]:—I should like to have Mr. Keyes tell something about other hot stampings than body stampings. What would be done by the hot-stamping method with a shape for a side frame, or a bridge casing for an axle, or a brake-drum to bring it down to an accurate size?

MR. KEYES:—This would not be a practical method to use on brake-drums that have to be brought down to accurate size, or for any job on which it is necessary to have the accuracy that is required on a brake-drum. However, I should say that it is altogether possible to make axle-housing stampings in halves, where the draw would not be straight. A number of things can be done by hot stamping that cannot be done otherwise. Recently we had occasion to make some shells for a petroleum company for advertising purposes. There are two sizes, one 2 ft. and the other almost 4 ft. in diameter, and they have all of the convolutions that appear in a natural marine shell. The making of these shells is a very difficult job but, by the pick-up process, it is possible to draw the metal down to the surface of the die and to finish it hot, reproducing the shape of the die exactly. It was not necessary to put any finely finished surface on the die, because the comparatively smooth casting, as it came from the foundry, was good enough for the purpose.

We also had occasion, some time ago, to make a front radiator-splasher for a car in which the tie-rod for the front wheels was in front of the axle. It was necessary to have the splasher drawn down and extend out possibly 3 or 4 in. to form a skirt, which made difficult stamping on the ends and sides. The center stamping was a simple piece but the sides were very complicated, yet it was possible to make those stampings with only one pair of dies. Ordinarily, to produce them by cold drawing, no doubt the stampings would be drawn down in two pairs in one blank, the shape being carried down in several operations, which would be the logical way to do it if the production were large enough to offset the amount of money that would have to be spent on the tools.

QUESTION:—How many sets of parts would mark the dividing line between small and large production when considering the hot-stamping and the cold-stamping processes?

MR. KEYES:—That would depend considerably upon how complicated a job was contemplated and the number of cold-drawing tools it would be necessary to make to produce the stamping cold. I should say that, ordinarily, if you have more than 300 or 400 stampings to make, it would warrant the building of hot-stamping dies, provided the job was not so complicated that it would mean an expensive set of dies, but the number of hot-stamping dies that could be made before the cost of cold-drawing tools was offset would depend largely on the nature of the stampings. We have one job that has run up to probably 200 stampings and if the number should go to another 1000 it would pay to make cold-drawing tools for the job. If production stops before that number is reached, the customer will have used good judgment in having had hot-stamping dies made, because he will have saved money by doing so.

M. R. WELLS[13]:—Is the asbestos lining on the die used solely as a heat insulator, or also for cushioning purposes?

MR. KEYES:—That is used for two purposes, as an insulator and for building-up low spots. If any particular part of a stamping is coming out a little high or a little low, a small quantity of asbestos can be added under the metal covering of the die to obtain more pressure at the desired spot.

MR. WELLS:—As you finally leave the die, does it have a certain amount of spring that follows up any irregularities of the stamping?

MR. KEYES:—The punch does have a certain amount of spring or cushion effect. However due to the pressure applied the punch forces the stamping to the surface of the die, but the cooling of the stamping will produce a small amount of metal strain in it. It is possible to raise the metal from the die in one place or another, which is corrected by the last cold run.

MR. WELLS:—What determines the life of the dies?

MR. KEYES:—They will run practically indefinitely on stampings that have no beads or sharp corners, unless a die should break. As for wearing out, they will run any number of stampings, but if the dies have beads the edges of the beads begin to crumble off after approximately 1500 or 2000 stampings have been run. The sharpness of the bead is lost.

MR. WELLS:—Does that refer to the female part of the die?

MR. KEYES:—Yes; the male portion is renewed very readily.

HARRY RODEMEYER[14]:—How many more or less stampings could you get by the hot-stamping method than by cold stamping?

MR. KEYES:—That depends upon whether or not the die has any sharp corners. I should say that, with a die that has a bead to produce a bead in the stamping, possibly 2000 would be the limit before that die would have to be redressed to sharpen up the beads. So far as the rest of the die is concerned, we have made 20,000 stampings with one die. We have been making Pierce-Arrow fenders for the last 8 years with the same dies. We never have replaced those dies, but they are perfectly smooth crowned.

MR. RODEMEYER:—Would they not wear out much faster in the hot process than in the cold process if the conditions were the same?

MR. KEYES:—Yes, without question. If you had large production, the cold process would be the one to follow. The only reason for using the hot-stamping process is to take care of limited production.

C. B. PALMER[15]:—Is there any increase in the amount of subsequent work that must be done on stampings that are worked out hot over those that are worked out cold, such as polishing and crowning after they are assembled?

MR. KEYES:—Yes, and that is what makes the hot stamping more expensive than the cold stamping. Naturally, the scale must be contended with when finishing it. In making a hot stamping it is necessary to heat the metal and, if the stamping is difficult to make, it must be heated to the temperature at which scale will form on the surface. That scale must be removed. We usually do that with the sand-blast and a certain quantity of the scale is bound to fall between the die and the stamping, which causes pits that must be finished up. However, if the stamping is not a difficult one to make, practically no finishing is required other than sand-blasting.

MR. WELLS:—Have you ever tried heating the sheets in a salt bath, or anything of that sort, to prevent the

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[12] M.S.A.E.—Body engineer, Cleveland Automobile Co., Cleveland.
[13] M.S.A.E.—Research engineer, Cleveland Automobile Co., Cleveland.
[14] Works superintendent, Barnes, Gibson, Raymond, Inc., Detroit.
[15] Superintendent of processing department, American Rolling Mill Co., Middletown, Ohio.

formation of scale? I believe there would be a possibility of that.

MR. KEYES:—We never have. We have heated the stampings in ovens, keeping the doors closed as much as possible.

R. P. F. LIDDELL[16]:—I should like to gain some idea as to the extent of application of this process. Is the Pierce-Arrow front fender made in one or in two pieces?

MR. KEYES:—In the type of fender that has no tire-well the crown is made in one piece and the apron in another, and the two are welded together, but the fender that has the tire-well is made in three pieces, the front and the rear sections and the apron, because the section with the tire-well has to be made wrong-sided to draw the tire-well. The most difficult part of the job is to form the tire-well in that portion, and for that reason we make it inside out. We wrap the metal down over the top of the die and then force the tire-well down into the stamping.

MR. RODEMEYER:—What kind of steel is used for the die?

MR. KEYES:—Semi-steel. The cast-iron die has steel added to the cast iron when the die is made. That construction was developed through experience in making metal cornices and ceiling, which did not require the finishing of the die. Some foundries developed means of making those dies by the addition of steel to the cast iron so that they had a very hard surface. For making dies for stampings that must have the scale removed and the surface finished, we add somewhere in the neighborhood of from 10 to 20 per cent of steel, but that cannot be mixed in the ladle. If it is mixed before pouring it will not improve the die but will cause hard spots. It has to be mixed in the cupola or it will not mix thoroughly.

MR. RODEMEYER:—In the case of the male die, would it be practical to put in steel inserts?

MR. KEYES:—We use steel inserts for the final operation of making the bead. For stamping a roadster side panel that has a bead extending its entire length, we make a bead out of ordinary mild steel, which works satisfactorily. The bead is formed to fit the shape of the die and is attached to the male die. The same method is followed where wheel housings have to be sharpened up, or sill lines, or wherever a sharp corner is required.

W. A. IRVIN[17]:—What temperature have you found most successful in making the hot stampings?

MR. KEYES:—We try to keep the temperature down just below the scaling temperature of the steel, because the formation of scale causes considerably more trouble in the finishing of the stamping. The temperature is controlled, of course, largely by the nature of the stamping, whether or not it has a particularly deep draw or sharp corners that have to be brought out. They are ordinarily run at about 900 to 1200 deg.

F. L. SNYDER[18]:—What is the comparative strength of a stamping made by the hot process with one made by the cold process?

MR. KEYES:—A stamping drawn hot is much stiffer than one drawn cold, because all of the metal strains are removed in drawing the hot stamping. As an illustration, if a deck panel is made hot, it comes out of the die with a set crown in it and no metal strains are present in that crown. But when making a comparatively flat door panel by the cold process, it is often necessary to power hammer it to form the crown, depending on the different tempers of steel. A comparatively soft sheet will maintain its crown, whereas a stiffer sheet will lose that crown.

MR. IRVIN:—Has it been found essential, in hot stamping, to have a sheet of particularly low carbon-content?

MR. KEYES:—Our experience is that the very best grade of automobile body steel having extra-deep drawing qualities is best. A soft sheet, with the greatest amount of elongation that is possible in an automobile body sheet, is desirable. However, we must be careful to obtain a sheet that has not had much cold-rolling, because one that has had too much cold-rolling and that carries a high gloss will scale very much quicker than one that has a dead surface or flat finish. As to the amount of carbon, the automobile body sheet has worked out better for our purposes than anything else.

MR. IRVIN:—Have you done any experimenting to determine whether or not an 0.15-per cent carbon sheet, as compared with an 0.08-per cent carbon sheet, will give better or worse results?

MR. KEYES:—No; but we have used all of the various kinds of steel available, such as automobile body, automobile body deep drawing and single-pickled blue-annealed, and have found that, for a stamping that has much of a draw, the best grade of extra-deep drawing stock is needed, because we use the drawing quality of the steel in all operations up to the point where the material is heated. When it is heated all of the extra-deep drawing qualities that are imparted in the tempering of the steel are destroyed. If it were not for the fact that we stamp it cold prior to the hot run, ordinary automobile body steel would be entirely satisfactory.

W. C. TAMPLIN[19]:—Do you ever have any trouble from stretcher strains, or material pulling coarse, from hot stamping?

MR. KEYES:—Indeed we do, because we use all of the drawing qualities of the steel until we make the hot run. In some cases we actually draw the steel in the break-down operations. We have had steel that was crystallized and when the hammer was dropped on it it would shatter, breaking with decidedly straight and sharp edges.

MR. TAMPLIN:—Do you have as much trouble with coarseness and stretcher strains in the hot stampings as in cold stampings?

MR. KEYES:—I think we do, but we would not have so much if the jobs were similar. More stretcher strains would be present in the cold-drawn than in the hot-drawn stampings, because, in the hot process, the metal is drawn down almost to the limit of its stretch. Such drawing sometimes puts a stretcher strain into a cold-drawn sheet that would not be present in a hot stamping.

[16] Chief engineer, Motor Improvements, Inc., Newark, N. J.

[17] A.S.A.E.—Assistant to vice-president, American Sheet & Tin Plate Co., Pittsburgh.

[18] Chief tool designer, White Motor Co., Cleveland.

[19] A.S.A.E.—Special representative, American Sheet & Tin Plate Co., Pittsburgh.

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Products and By-Products of Foreman's Conferences

By FRANKLIN T. JONES[1]

PRODUCTION MEETING PAPER *Illustrated with* CHARTS AND DIAGRAMS

ABSTRACT

THE technique of introducing, conducting and auditing foreman training is presented in detail, reference being made to four main sources of information from which liberal quotations are made and commented upon. Actual methods used and results from foreman training are related by the author, who also discusses the fine points of successful procedure.

Among the important features of educating foremen so that they can attain higher levels of average practice are the selection of competent conference leaders, proper comprehension of the foreman's viewpoint and the inspiration of his confidence in the sincerity of the management. Conference topics are suggested and it is advised that these be presented to successive small groups of men who constitute a fair "sample" of the organization rather than to all the foremen simultaneously.

Charts illustrating how the higher levels of intelligence are attained by such means are presented and methods of follow-up that assure permanence of the training, with statements of proper subjects for study to supplement the conferences, are explained.

Means for deducing tangible results from the foregoing educational process are given in detail. Direct results are considered to be products, and indirect results are counted as by-products; from them, the men can be rated and ranked. A summary is made in conclusion.

FOREMAN training has been discussed and rediscussed so many times that any new paper on the subject is likely to cover the same old ground again. At one time foreman training was in question, and arguments for and against some form of training constituted a live topic. The subject matter of such a course has been written and rewritten until now it is more a matter of deciding what material to select than it is of where material can be found, and what system shall be followed rather than to devise a plan. But the products and by-products of foreman training in a manufacturing organization and the technique of introducing, conducting and auditing the training are not altogether old and well known. A great supply of information is scattered through books and articles, but the really fundamental things can be derived in condensed form from four sources.

The first reference, The Foreman, a Treatise upon the Qualifications, Powers, Duties and Relations of a Foreman in Manufacturing,[2] is an unusual document which is unfortunately out of print. The welfare of industry demands that this bulletin be reprinted and given wide distribution. The chapter headings in this publication give a good idea of the subjects requiring discussion in any series of foremen's conferences. They are listed by chapter number and title as follows:

(1) Introductory
(2) Modern Organization Methods
(3) Modern Production Methods
(4) Personality
(5) Handling Men—Selection
(6) Handling Men—Leadership
(7) Handling Men—Technical Knowledge
(8) Discretionary Powers of a Foreman
(9) Duties of a Foreman
(10) Conservation
(11) The Foreman on Staff Duty
(12) The Management's Obligation to the Foreman
(13) Organizing Collective Training for Foremen
(14) Women Workers

An excellent outline of the chapter that follows is printed beneath each chapter heading and these outlines can be used readily as the subjects of a series of meetings.

The second reference, The Industrial Supervisor, His Characteristics, Duties, Responsibilities and Opportunities,[3] is an unusual piece of work describing the development of supervisory training on the part of the Westinghouse Electric & Mfg. Co. The stated purposes of this series of meetings was to

(1) Develop the habit of creative and constructive thinking
(2) Obtain the correct understanding of the company's ideals, policies and management
(3) Afford the supervisor, as an individual, a better opportunity to express his views concerning these ideals, policies and management
(4) Develop the fact, that, fundamentally, the interests of all Westinghouse employes are identical, and to promote these interests through the media of intensified cooperation and sympathetic understanding
(5) Show more clearly the close relationship and interdependence existing between the supervisor's work and that of all other departments, such as sales, engineering, purchasing, store-keeping, employment, rate, production, cost, inspection, testing, maintenance and shipping
(6) Broaden the supervisor's general knowledge of industrial problems, by contact with other supervisors and executives
(7) Give the supervisor a true prospective regarding his responsibilities and opportunities
(8) Develop the qualities of the supervisor, particularly with respect to leadership, for proper training will enable one to supervise with poise, confidence and intelligence

The third reference, Foreman Training, issued by the Pittsburgh Personnel Association,[4] is divided into three parts that are self-explanatory and sufficiently specific to serve as a guide for any company that is considering the introduction of any form of foreman training. The three parts are: Why have foreman training, what to

[1] Supervisor of training, White Motor Co., Cleveland.
[2] See Department of Labor Training Bulletin No. 26.
[3] See The Industrial Supervisor, published by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
[4] See Foreman Training, published by the Pittsburgh Personnel Association.

include in foreman training and how to conduct foreman training.

The fourth reference is a report, published in 1922, of a committee of the then National Personnel Association,[5] now the American Management Association. The divisions of this report are self-explanatory. being as follows: The leader method, the conference method, the text-study method, the field training of foremen, the following up of foreman-training work and the production conference versus foreman training.

Obtaining Conference Leaders

The state departments of vocational education are permitted under the Smith-Hughes and Vocational Rehabilitation Acts to provide facilities through the local boards of education for training teachers for those engaged in industry. Very wisely, these powers have been directed toward the training of foremen on the ground that foremen are the teachers of the men in their departments. Therefore, under the law, it is possible to use public funds in foreman training. It is then possible in almost all places in the United States to enlist the services of the local board of education in assisting with foreman training. This training is usually given under the name of foremen's conferences for reasons that are obvious to those who have had experience with foremen.

The large majority of foremen have come up from the ranks of workmen. They have been selected because they possess certain characteristics that make it possible for them to render great assistance in "getting out the work." The ordinary foreman's way of thinking differs only in degree from that of the workman whose activities he directs. He is naturally suspicious when he is called into a production conference and told about a new policy or given directions for changes within his department. He wonders what is being put over. If his name is listed as one of those to take "foreman training," he will accept the appointment just as he would accept any other order given to him by a superior. He will do his best to enforce every letter of the law and to be able to say "I did just what you told me to." He may not be at all convinced that the training will be useful to him, or that it really will promote the interests of the company. Generally he will look upon it as a means of "getting something on him."

In view of these facts, executives in industry have done wisely to call in the Smith-Hughes men and have them carry on training by the "conference method." These leaders usually are men of industrial experience, in many cases being ex-superintendents and foremen who have shown unusual skill in adapting themselves to groups of more or less hostile or apathetic foremen and getting them to talk about their jobs, frequently on the ground that this is done to put across ideas with groups of workmen or other foremen. It is better for the leader of such a group to be a person who has no authority over the individual members of the group. It is therefore a mistake for the initial foreman-training to be carried on by a conference leader who is a member of the organization in authority. Only in the rarest instances will he be able to gain frank and fair discussion and a full expression of these ideas which it is most important that the members of the group consider. It will always be felt that such a person will make use of information thus brought out, possibly in a hostile manner.

The outsider, however, must be a man of judgment who can lead the discussion wisely in directions profitable to the company. It is advisable that he spend a considerable period inside the factory itself, looking over departments, observing methods of manufacture, talking with executives, and making himself virtually a member of the organization. In other words, he must master the policies and principles of the organization as well as the product if he expects to attain more than mediocre success with the group of foremen for whom he is conducting conferences. Fortunately, the men doing this sort of work are selected wisely and are able to enter one industry after another without becoming disturbing factors within those industries.

As the Foreman Sees It

The old-time foreman knew the boss as well as he knew his own men. He was the direct link between the manager-owner of the business and the workmen. Usually, he was a man who had served a trade apprenticeship and possessed that job knowledge which we now know is such a vital element for success on the part of a good foreman. He had qualities of initiative, ambition and the like which had attracted his employer's attention and had led to his selection as a production partner in the business. Frequently, the boss called him in, showed him a job that had been taken and asked him to look it over. The foreman was then expected to go out and put the job across. Not infrequently he first made his own drawings, planned the tools, made the patterns, ordered the machines and assigned the work. At present many foremen can do the same thing, but it has been found that, in general, such a method of operation results in great wastefulness, lack of coordination of effort and failure to make profits. Accordingly, the modern foreman must fit himself into a scheme adapted to a modern system of production.

With the institution of a planning department, the foreman has felt that a part of the job which he very much enjoyed putting across has been taken from his hands. He is inclined to think now of his job as merely a mechanical carrying out of the orders of others but, in fact, he is still the "manager" of his own department. His powers have not been large but they have not decreased in a way to interfere with those opportunities that make him enjoy his job. It has, therefore, become increasingly necessary that the present-day foreman examine his own activities and his own mental operations to find out just what his proper functions should be and just how he will carry out these functions. He likes to talk about his job and, in particular, his own methods of making that job a success. The conference leader seizes upon this opportunity to teach by the conference method. The foreman is accustomed to feel that he is used to put things across for the management. Frequently, he does this without understanding the justice or the necessity of the measure in question.

Method for Inspiring Confidence

In establishing foremen's conferences, the greatest care must be taken that the method used shall inspire confidence. It is not at all infrequent to find management cautious, or even over-cautious, in plans it makes for meetings of employes. Measures poorly conceived or carelessly executed are most likely to produce dissatisfaction, discontent and unrest among the workmen. Satisfactory production cannot be maintained by dissatisfied workers. Management cannot, therefore, use too great care in its method of installing foremen's conferences.

[5] See Foreman Training Methods, published by the National Personnel Association, now the American Management Association.

Wise management will see to it that the entire organization is "sold" with regard to any measure before it is put into effect. This is particularly necessary in so important a measure as foremen's meetings. A manufacturing committee will do well to call in the possible conference leader and have him explain the plans and the program that he expects to put into effect. In this manner the members of the manufacturing committee have an opportunity to judge the wisdom of the conference leader and to decide whether their confidence in him will justify turning over to him one of the most important functions of the entire organization. This leader has it within his power to confer a great benefit or to produce great damage. The conference leader should have back of him a known record of performance. It is to his advantage if he has himself been a foreman and if he possesses those personal qualities of leadership which will overcome suspicion and inspire confidence.

Conference Topics

The following outline of topics was used successfully with a foremen's-conference group, such as has been described, having been revised after experience with Group 1 by R. D. Bundy, conference leader of the Cleveland Board of Education.

FOREMEN'S CONFERENCES II

April 14, 1925

OUTLINE OF TOPICS—GROUP II

- (*A*) *Managerial*
  - (I) The two periods of industrial development
    - (1) The craftsman period
      - (*a*) Advantages and disadvantages, based upon means of communication, transportation and invention
    - (2) Quantity-production period
      - (*a*) General and economic advantages
  - (II) The foreman's problems incidental to production
    - (1) Classification of responsibilities of the modern foreman
    - (2) Definition of management and supervision
  - (III) The problem of human relations
    - (1) Enumerating types of workmen
      - (*a*) Classifications
      - (*b*) Methods of handling
    - (2) Handling the careless employe
      - (*a*) Types of carelessness
      - (*b*) Methods of prevention
  - (IV) The problem of holding the desirable employe
    - (1) Definition of interest
    - (2) Methods used to secure interest
  - (V) The foreman as a leader
    - (1) Leadership qualities
    - (2) Self-analysis of leadership qualities
  - (VI) Disciplining of employes—Can a foreman be a leader and at the same time be a strong disciplinarian?
    - (1) Definition of discipline
    - (2) Fundamentals
    - (3) Managerial factors in the enforcement of discipline
    - (4) Orders, directions and suggestions
  - (VII) The problem of giving and securing cooperation
    - (1) Definition
    - (2) Horizontal and vertical
    - (3) Causes of poor cooperation
    - (4) Factors of good cooperation and effects
- (*B*) *Supervisional*
  - (VIII) Supervisional responsibilities of a foreman
    - (1) Review definition of supervision in its relation to management
    - (2) How can supervision be made complete?
      - (*a*) Enumeration and discussion of methods
    - (3) Departmental records
      - (*a*) The objectives of a system of records
      - (*b*) Necessary elements to make records effective
- (*C*) *Instructional*
  - (IX) Typical attitude of new workers
    - (1) How do they behave?
  - (X) Instruction of workers
    - (1) Analysis of quotation: "Teach. Don't boss"
    - (2) What is teaching?
    - (3) How do we learn?
  - (XI) Discussion and demonstration of principles in teaching
    - (1) Preparation
    - (2) Presentation
    - (3) Application
    - (4) Testing
  - (XII) Job analysis, definition of
    - (1) Payroll job
    - (2) Work job
    - (3) Operation
    - (4) Operation points
    - (5) Demonstration and discussion of analyzing a job
  - (XIII) Summary of course

The foregoing outline can be covered successfully in from 24 to 30 meetings of 1 hr. each. This particular group contained about 25 foremen selected from departments throughout the organization.

Successive Small Groups Desirable

At this point it is advisable to call attention to an important item in the conduct of foremen's conferences. It is a school idea that people should be kept in groups and that all should be given the same treatment. Accordingly, we are tempted to believe at first that *all* the foremen of an organization should enter into conferences at the same time; but a little deeper consideration of the problem shows that better results can be expected by conducting conferences with a "sample" of the organization. This purpose can be illustrated by the simple diagram reproduced in Fig. 1.

Suppose we represent the level of thought on the problems of management by the block *A*. Let us select foremen from departments throughout the organization, put them into a group and discuss with them their problems for a period of 3 months. The result of the discussion upon the members of this group raises their level of thought above that of the common level, let us suppose to the level *B*. Each man has gone from the meeting back into his own department and has practised at least some of the principles that have been developed in the conferences. In so doing he has been instrumental in raising the level of thought and practice of the whole factory to what we may designate as level *C*. In other words, the whole organization has benefitted by the instruction given to the first group.

Now suppose that we form a second group, selected in such a way that its members are representatives of the entire organization; that is, instead of selecting all the foremen of the department and giving them training at one time, we will select one man each from the departments represented by the numbers 118-*B*, 131-*D*, 161-*E*, 171-*H*, 301-*F*, 311-*M*, 411-*P*, and so on. The level of thought and practice at which members of this group begin their discussion is not the original level *A* but the level *C*. On discussing the same subjects, it may be as-

sumed justly that they in turn will raise their level to a new value, *D*, and their reaction upon the whole organization will be represented by the level *E*. Actual practice confirms this idea, and so we are justified in recommending that an organization will do well to divide its men for foremen's conferences into successive rather than into concurrent groups. By this device, progress will be made by a series of steps rather than by mere impulses.

Further, let us consider the effect on the members of Group I due to the fact that Group II is rediscussing its problems on a higher plane or is considering a set of problems of a higher degree of complexity. The members of the group will be stimulated to maintain more nearly the level to which they had risen while their own conferences were in progress. In other words, their interest in training will be sustained and intensified by the formation of successive groups.

Making Training Permanent

Training in industry has a decided tendency to be sporadic. When a man or a group of men has advanced ideas in management and succeeds in putting them into effect and, as a result, the organization embarks upon a program of training that may be very pretentious, an enthusiastic supervisor of such work is very likely to oversell its value and to expand its activities faster than the organization can benefit by them. Then, inevitably, men for advanced positions are developed faster than they can be placed. Unrewarded ambition and merit make them dissatisfied employes. If they remain within the organization they become trouble makers and re-

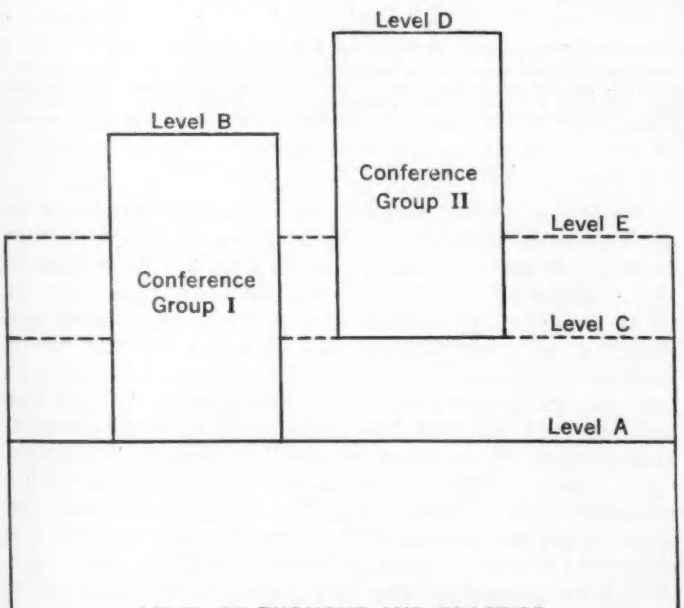

Fig. 1—Levels of Thought and Practice on the Problems of Management
The Common Level of Intelligence *A* Is Raised to a New Common Level *C* by Discussion of the Problems of Management with the Foremen of Group I and Raising Their Group Intelligence to Level *B*. Similarly, Since the Common Level of Thought and Practice from Which Group II Begins Its Discussion Is Not the Original Level *A* But Is the Higher Level *D*, Due to Discussion, the Common Level Is Raised from Level *C* to Level *E*

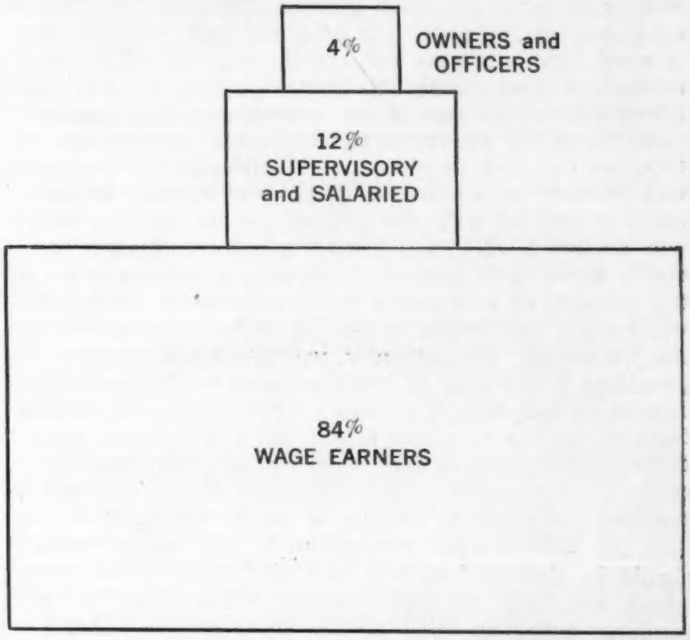

Fig. 2—The Structure of Industry
Analysis of the Last Census Shows That Less Than 4 Per cent of All Those Gainfully Occupied Are Proprietors, Officers and Directors of Corporations, and They Occupy the Major Salaried-Positions. Those Gainfully Occupied in Subordinate Supervisory and Salaried Positions Constitute 12 Per Cent and 84 Per Cent Are Designated as Wage Earners. Management Represents 4 Per Cent; It Includes the People upon Whom Industry Depends for the Planning of Its Activities. This Group Supplies the Major Ideas and Plans That Are Transmitted to the 84 Per Cent by the Agency of the 12 Per Cent

flect unfavorably upon the morale of all with whom they come into contact. The training program becomes too extensive, business becomes slack, retrenchment is necessary and the inevitable necessity for economy compels curtailment of training opportunities and activities. Hence, we see training in industry proceeding in an organization as a succession of waves, each with its crest and trough, instead of as a steady progress represented by an inclined plane. It is evident that foremen's conferences as a succession of groups rather than as a simultaneous activity of all the foremen in the organization has very definite advantages. Likewise, over-expansion in training activities is just as serious a business blunder as over-expansion in production or in sales activities.

The time is bound to arrive when all the foremen of an organization have passed through the series of preliminary conferences. Suppose we consider for a moment the effect upon Group I. If, at the end of the series of 30 conferences, its activities along this line cease, the members will suffer the inevitable reaction and their plane of thought, practice and endeavor will recede to a point not very different from the original level *A* in Fig. 1 from which it started. Such an effect is highly undesirable and should be avoided by some satisfactory device. We know that training, either of the hand or of the head, is slow, even in school where it was a principal business to which nearly half of our waking hours were devoted. The effects produced were small in proportion to the time spent and rarely more than kept step with the increasing age of the student. Can we expect education in industry to be either more permanent or to proceed at a more rapid rate?

Subjects Following Foremen's Conferences

The age at which we learn most easily has already been passed by the time that a man has become a supervisor or foreman. He follows new lines of thought and

new forms of action with greater difficulty. His interest in his job, however, is maintained, and it is upon that interest that stimulus for continuation of effort must depend. We see men in the thirties and forties and even fifties taking correspondence courses and studying subjects frequently unrelated to their jobs. All will not do this, nor can they be stimulated to attempt it, but a certain number in whom the desire for further advancement is coupled with the willingness for further effort will always be found. Accordingly, out of each foremen's group it is possible to form a similar group for the purpose of continuing those subjects of study that will make a man better on his job or better prepared for the job ahead. Consequently, we should look forward to providing a sequence of work adapted to the needs and desires of men who have been in foremen's conferences. Such a possible sequence might be: conferences, manufacturing problems or industrial management, budgetary control, and economics. It really seems that this sequence reverses our common method of learning. Many would have us believe that economics is the subject which should be studied first as a basis for the other subjects which are here mentioned ahead of it. But we are familiar with the fundamental principle in education that we learn through that which already is present in our own minds. Therefore, the development of the foregoing sequence of subjects is a much more certain method of obtaining lasting training than the method used in the schools of developing a subject logically from its elements.

LEADERSHIP ANALYSIS CHART

The following Leadership qualities can be used **as a basis** for self-analysis:

The qualities in which one feels he is sufficiently strong should be marked "10". For instance, if, in his own judgment, he is entirely unselfish he should mark unselfishness "10". On the other hand, if he is weak in other qualities, he should estimate his weakness on a basis of 10 as perfect. This weak quality may run anywhere from 0 to 10, depending upon his own estimate.

Through this analysis the weak points are realized. It is then possible to work out a plan for their development.

	QUALITIES	RATINGS										
		0	1	2	3	4	5	6	7	8	9	10
1.	Initiative											
2.	Fairness											
3.	Integrity											
4.	Planning ability - system											
5.	Judgment											
6.	Diplomacy											
7.	Tact											
8.	Thoroughness											
9.	Aggressiveness											
10.	Determination											
11.	Memory											
12.	Confidence											
13.	Expression											
14.	Energy - pep											
15.	Self-control											
16.	Loyalty											
17.	Punctuality											
18.	Job knowledge											
19.	Unselfishness											
20.	Ability to stand criticism											
21.	Appearance											

FIG. 3—ANALYSIS OF LEADERSHIP
The Qualities To Be Rated Were Proposed by the Men

LEADERSHIP ANALYSIS CHART

The following qualities can be used as a basis for **self-analysis**. The scale is divided from 0 to 10. In rating the entire range of the scale should be used, not merely the upper part.

In order to obtain results from a variety of raters that can be compared, please keep in mind these relations between numbers and descriptions. If **distinguished** in the character rated, put a check mark on the line under the 10.

Excellent	— 9	**Fair**	— 7 or 6	**Below Average**	— 4, or 3
Good	— 8	**Average**	— 5	**Poor**	— 2, or 1

By this method weak characteristics can be realized and corrected.

	QUALITIES	RATINGS										
			Poor		Below A		Av.	Fair		G	E	D
		0	1	2	3	4	5	6	7	8	9	10
1.	Initiative											
2.	Fairness											
3.	Integrity											
4.	Planning ability - system											
5.	Judgment											
6.	Diplomacy											
7.	Tact											
8.	Thoroughness											
9.	Aggressiveness											
10.	Determination											
11.	Memory											
12.	Confidence											
13.	Expression											
14.	Energy - pep											
15.	Self-control											
16.	Loyalty											
17.	Punctuality											
18.	Job knowledge											
19.	Unselfishness											
20.	Ability to stand criticism											
21.	Appearance											

FIG. 4—FINAL FORM OF LEADERSHIP ANALYSIS
This Form Succeeded That of Fig. 3. Attention Is Called to the Method of Rating Presented. The Titles and Ratings Accomplish the Desired Purpose of Distributing Ratings Over the Entire Scale. This Device Was a Direct Result of Foremen's Conferences

THE STRUCTURE OF INDUSTRY

A picture of our problem in its largest sense can be derived more clearly by consideration of the structure to which it must be applied, as in Fig. 2. According to the analysis of the last census, less than 4 per cent of all those gainfully occupied are proprietors, officers and directors of corporations, and they occupy the major salaried-positions. Those gainfully occupied in subordinate supervisory and salaried positions constitute 12 per cent, and 84 per cent are designated as wage earners. Management represents 4 per cent; it includes the people upon whom industry depends for the planning of its activities. This group supplies the major ideas and plans that are transmitted to the 84 per cent by the agency of the 12 per cent. Clearly, the 12 per cent must be able to understand the ideas, orders and directions of the 4 per cent for, otherwise, they will not be able to interpret them to the 84 per cent. Likewise, they must understand and be sympathetic with the problems of the 84 per cent because, otherwise, they cannot correctly interpret the feelings, ambitions and desires of the large body of wage earners to the management.

Again and again we have heard it stated that the foreman is the keyman in the industry. The foreman is a member of the 12 per cent and this responsibility demands an understanding even greater than that of the managers of industry, since he must be able to interpret satisfactorily the difficult and complex ideas of management to the workers. Correct economic ideas throughout the whole body of those gainfully occupied depend

upon the success with which this intermediate group is trained. Up to the present, the most of this training has been left to chance and to that confidence in the natural integrity of man upon which we have not yet relied in vain. We clearly have no business to leave so important a matter to chance, or to any except the most thorough and painstaking thought.

Products and By-Products

It easily would be possible to speculate upon the products as well as upon the by-products of foremen's conferences but, instead of speculation, I will set forth some of the products and by-products that have been observed by members of an organization in which foremen's conferences have been conducted. These statements are given in part by those who have attended the conferences, in part by their immediate superiors and in part by those who have had an opportunity to see the effects as produced. After conducting a series of foremen's conferences followed by a series of meetings on industrial management, the accompanying letter was sent to the foremen, the superintendents and the higher executives in the company.

THE WHITE MOTOR COMPANY
Departmental Correspondence

July 20, 1925.

SUBJECT: *Products and By-products of Foremen's Conferences.*

Department Heads, Superintendents and Foremen,
Gentlemen:—Last October a group of about 25 foremen began to attend a series of *Group Conferences for Foremen.* On April 2, 1925, a second group of foremen also began to meet for a similar series of conferences.

Some of those to whom this letter is addressed attended these conferences. Some are their immediate supervisors. All have had opportunity to observe the effects of these meetings.

We are interested in knowing your opinion concerning

Products and By-products of Foremen's Conferences.

"Products" are the *direct results;* "By-products" the *indirect results* of these conferences.

Please write your opinions on the attached sheet and return. A prompt reply will be greatly appreciated.

Very truly yours,
FRANKLIN T. JONES,
Supervisor of Training.

The attached sheet referred to in the foregoing letter conveyed, in effect, the following request: Please enter your observations on the products and by-products of foremen's conferences and return to Franklin T. Jones, supervisor of training, as soon as possible, stating products in direct results, by-products in indirect results and mentioning what undesirable effect, if any, has resulted. The replies resulted in the following summary of the products and by-products of foremen's conferences in a manufacturing organization.

Direct Results, Products

(1) Better understanding of responsibilities and duties

June 8, 1925.

INFORMATION SHEET NO..............

You are asked to give some confidential information concerning the employee whose name has been given you under the key number .... Your name will not be used. For convenience and uniformity please put this information on the tabular form below. You are asked to express your opinion on the **Abilities, Capacities, Qualifications** and **Qualities** listed with the following understanding—

if **Distinguished** (D), put a check mark on the line marked 10; similarly for

Excellent	(E) — 9	**Fair** — 7, or 6	**Below Average**	— 3, or 4
Good	(G) — 8	**Average** — 5	**Poor**	— 2, or 1.

Please remember that the entire range from 0 to 10 is available, not merely the upper part of the scale. Information concerning characteristics in which weakness is shown can be made a basis for improvement and correction.

		Poor		Below		Av.	Fair		G	E	D
	0	1	2	3	4	5	6	7	8	9	10
ABILITIES											
To accept and profit by criticism and correction											
To get along with other people											
To give directions and orders											
To handle men											
To organize (plan, classify, delegate, supervise)											
CAPACITIES											
Adaptability to changes in methods and systems											
Cooperation - give and take											
Fairness											
Interest in Company's problems											
Judgment and common sense											
Willingness to accept responsibility											

		Poor		Below		Av.	Fair		G	E	D
	0	1	2	3	4	5	6	7	8	9	10
QUALIFICATIONS											
General merit											
Job knowledge											
Leadership											
Personality											
QUALITIES											
Ambition											
Physical vigor											
Initiative - starting things											
Loyalty											
Reliability											
Thoroughness											
Self reliance											

FIG. 5—THE INFORMATION SHEET
This Represents the Indirect Result or By-Product of Foremen's Conferences. It Is Possible by This Sheet To Obtain Ratings from Which Rankings for Purposes of Promotion Can Be Prepared. The Sheet Presents Striking Evidence of Both Direct and Indirect Results from Foremen's Conferences

(2) Better slant on the other fellow's problems
(3) Larger and better acquaintanceship
(4) Better cooperation
(5) Better tact and diplomacy
(6) Thinking about the foremen's job
(7) Philosophy of handling men
(8) Self-analysis
(9) Opportunity for self-expression
(10) Getting management's point of view
(11) Greater interest in the job
(12) Preparation for promotion

Indirect Results, By-Products

(1) Interest in the company's problems
(2) More progressive toward new methods
(3) Men get together to figure out problems
(4) Coordinating own work with that of others
(5) Broader vision on common problems
(6) Increased efficiency, becoming more businesslike
(7) Finding the proper man for a given job
(8) Rating and ranking men
(9) Substitute discussion for argument
(10) Convince foremen that management wants them to progress
(11) Willingness to receive training
(12) Executives learn to know the men better

Many more results of both kinds might have been tabulated from the answers sent in, but the foregoing are sufficient to show the character of the effects felt from foremen's conferences. No undesirable effects were observed.

Ratings and Rankings

In connection with Topic V—The Foreman as a Leader—a leadership-analysis chart was developed. Qualities to be rated were proposed by the men themselves. After experimenting with several rating-forms, the chart was finally submitted to them in the form shown in Fig. 3. The story of the development of Fig. 3 and its successor, Fig. 4, is too long for narration here. It is sufficient to show the charts themselves and to call attention to the method of rating described near the top of Fig. 4. The titles—Distinguished, 10; Excellent, 9; Good, 8; Fair, 7 and 6; Average, 5; Below Average, 4 and 3; and Poor, 2 and 1—accomplished the desired purpose of distributing ratings over the entire scale. This device was a *direct result*, or product, of the foremen's conferences. The *indirect result*, or *by-product*, is illustrated in Fig. 5, the Information Sheet. It is possible by this sheet to obtain *ratings* from which *rankings* for purposes of promotion can be prepared. This, in particular, is a striking instance of both direct and indirect results from foremen's conferences.

Summary

(1) The references at the beginning of the paper give sufficient information for any who may wish to look into the subject of foreman training
(2) The leader for foremen's conferences should not be a person in authority over the individual members of the group. He should be accepted in the organization only after the most rigid investigation into his wisdom and discretion, since he will have such great opportunities either to benefit or to injure the organization
(3) A satisfactory series of conferences can be based upon an outline similar to the one shown in full in this paper
(4) The manner of selecting groups of foremen for the conferences is highly important. It is recommended that small successive groups of foremen participate in conferences, rather than large or simultaneous groups. In this manner, not only can interest be aroused better but it can be maintained more successfully, and the level of thought and practice inside a manufacturing organization can be advanced permanently
(5) The management group comprising 4 per cent of those gainfully employed depends upon foremen and others, who constitute 12 per cent, to interpret the necessary moves of business to the wage earners who make up the remaining 84 per cent. The entire organization should be trained to understand and practice modern business methods. Foremen's conferences will bring together harmoniously and effectively the 4 and the 84 per cent. When part of an organization is trained, some of the results of that training are communicated to the entire organization
(6) Products or direct results and by-products or indirect results of foremen's conferences are very numerous. Some of them, as reported in one organization, are tabulated
(7) As a specific illustration of products and by-products of foremen's conferences, it is shown how ratings and rankings were developed in one organization

[The discussion of this paper is printed on p. 54.]

JOHN H. DOHNER

FOLLOWING the conclusion of his speech in the Masonic Temple, Dayton, Ohio, made during the Scottish Rite ceremonial, John H. Dohner, president and manager of the Ohio Metal Products Co., was stricken with apoplexy and died on Nov. 11, 1925, aged 63 years. He was born on May 31, 1862, in Champaign Co., Ohio, and, from 1889 to 1907, was assistant factory manager for the National Cash Register Co. in Dayton.

Becoming assistant superintendent of the National Acme Co., Cleveland, in 1907, Mr. Dohner continued this activity until 1909. He then was made the executive head of the Ohio Metal Products Co. and was still active in that capacity at the time of his sudden death. He was the patentee of the Dohner compression coupling manufactured by his company. Mr. Dohner was elected to Associate Member grade in the Society on Sept. 25, 1920.

Applicants *Qualified*

The following applicants have qualified for admission to the Society between Nov. 10 and Dec. 10, 1925. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff) Affiliate; (S M) Service Member; (F M) Foreign Member.

ABBOTT, ROBERT D. (M) manager of tire development department, Miller Rubber Co., South High Street, *Akron, Ohio.*

ADAMS, BURNHAM (J) experimental engineer, Wright Aeronautical Corporation, *Paterson, N. J.;* (mail) 141 Ellison Street.

AYRES, H. D. (M) physicist, B. F. Goodrich Co., *Akron, Ohio.*

BAIRD, GORDON F. (J) research assistant, General Motors Corporation Research Laboratories, General Motors Building, *Detroit.*

BAKER, CHARLES F. (A) sales engineer, Dayton Steel Foundry Co., *Dayton, Ohio;* (mail) 927 North Euclid Avenue.

BEANS, CHARLES D. (A) purchasing agent, Beans Spring Co., *Massillon, Ohio.*

BELANGER, J. (M) body tool engineer, American Body Co., *Buffalo;* (mail) 1068 Elmwood Avenue.

BETTIS, FIRST-LIEUT. CYRUS (A) Air Service, Selfridge Field, *Mount Clemens, Mich.*

BJORNBERG, S. O. (M) consulting engineer, Illinois Tool Works, 2501 North Keeler Avenue, *Chicago.*

BOHNER, CLYDE C. (M) assistant to president, Tung-Sol Lamp Works, 95 Eighth Avenue, *Newark, N. J.*

BOND, FRANK A. (A) vice-president and general manager, U. S. Chain & Forging Co., 575 Union Trust Building, *Pittsburgh.*

BROADBENT, HAROLD S. (A) commercial engineering, Westinghouse Lamp Co., P. O. Box 100, *Bloomfield, N. J.*

BROWER, CAPT. GERALD EVANS (S M) engineering division, Air Service, McCook Field, *Dayton, Ohio.*

BROWNE, DONALD H. (J) engineer, New Departure Mfg. Co., *Bristol, Conn.;* (mail) Endee Inn.

BURRELL, GEORGE A. (M) consulting chemical engineer, *Pittsburgh;* (mail) Ruskin Apartments, Ruskin Avenue.

CARTHAUS, WILLIAM J. (J) secretary and treasurer, Correct Motor Fuels, Inc., *Alton, Ill.*

CHURGAY, L. A. (M) plant equipment engineer, Chrysler Corporation, *Highland Park, Detroit;* (mail) 8428 Cahalan Avenue.

COLLINS, W. D. (M) chief engineer, H. C. S. Cab Mfg. Co., *Indianapolis;* (mail) 4923 College Avenue.

D'ARCAMBAL, A. H. (M) metallurgist and sales engineer, Pratt & Whitney Co., *Hartford, Conn.*

D'ARDENNE, W. H. (A) development engineering, Heintz Mfg. Co., Philadelphia; (mail) 510 Robbins Avenue, *Lawndale, Philadelphia.*

DAUM, CARL C. (J) drafting, Maccar Truck Co., *Scranton, Pa.;* (mail) 1348 Sanderson Avenue.

DAVENPORT, H. A. (A) assistant division manager, Mack-International Motor Truck Corporation, 132 East 23rd Street, *Chicago.*

DEVEREAUX, WILLIAM C. (A) president and general manager, Ferro Stamping & Mfg. Co., 1379 Franklin Street, *Detroit.*

DINGLE, HOWARD (A) vice-president and general manager, Cleveland Worm & Gear Co., 3249 East 80th Street, *Cleveland.*

DIXON, WALTER LOUIS (M) superintendent, International Motor Co., New Brunswick, N. J.; (mail) 225 Adelaide Avenue, *Highland Park, New Brunswick, N. J.*

EBERHARDT, FRANK E. (A) vice-president and works manager, Newark Gear Cutting Machine Co., Newark, N. J.; (mail) 234 Raymond Avenue, *South Orange, N. J.*

EBERHARDT, U. SETH (A) superintendent, Newark Gear Cutting Machine Co., Newark, N. J.; (mail) 26 Oberlin Street, *Maplewood, N. J.*

EDMONSTON, RALPH T. (A) superintendent of Washington terminal, Tidewater Lines, Inc., *City of Washington;* (mail) 1454 S Street, Southeast.

EISENBERG, CHARLES, JR. (J) engineer, Hydro-Hoist Co., *Milwaukee;* (mail) 652 26th Avenue.

FAIRBANKS, WILLIAM H. (M) supervisor of shops and vehicles, Southern California Telephone Co., *Los Angeles;* (mail) 1158 San Pedro Street.

FAIRHURST, WILLIAM (A) salesman, Spicer Mfg. Corporation, *South Plainfield, N. J.*

FERRANDOU, A. H. (A) manager of motorcoach sales, Graham Bros., Lynch Road, *Detroit.*

FLOYD, JOHN M. (M) factory manager, Sheldon Axle & Spring Co., *Wilkes-Barre, Pa.*

FRITSCHE, CARL B. (A) general manager, Aircraft Development Corporation, General Motors Building, *Detroit.*

GARLAND, E. C. (M) technical manager, Cadillac Motor Car Co., Detroit; (mail) 142 McLean Avenue, *Highland Park, Detroit.*

GRAHAM, HERBERT W. (M) chief inspector, Jones & Laughlin Steel Corporation, *Pittsburgh.*

GROTENHUIS, WILLIAM J. (A) vice-president, Biflex Products Co., Waukegan, Ill.; (mail) 1609 Sherwin Avenue, *Chicago.*

GWYN, LEWIS R., JR. (J) assistant superintendent, American Railway Express Co., 714 Atlantic Avenue, *Brooklyn, N. Y.*

HAHN, ADAM S., JR. (J) chief draftsman and assistant sales manager, Hahn Motor Truck Co., *Hamburg, Pa.;* (mail) 238 Pine Street.

HAMILTON, MAJOR CHARLES S. (A) Quartermaster Corps, *Fort Leavenworth, Kan.*

HENDERSON, PAUL (A) general manager, National Air Transport, Inc., 847 Earle Building, *City of Washington.*

HENRY, JAMES S. (J) engineer, Commerce Motor Truck Co., *Ypsilanti, Mich.*

HOLMES, FRANK (M) superintendent of engine works department, Imperial works, Oil Well Supply Co., *Oil City, Pa.*

HUNTINGTON, E. E. (M) electrical engineer, Willys-Overland Co., *Toledo.*

JETT, GEORGE C. (M) mechanical engineer, Jett & Stiemke, *Milwaukee;* (mail) 395 Summit Avenue.

JONES, YOUNG B. (A) manager of National accounts, Northeast Division, Mack-International Motor Truck Corporation, 1732 Jefferson Avenue, *Buffalo.*

KERR, J. M. (A) assistant sales manager, Hayes Wheel Co., South Horton Street, *Jackson, Mich.*

LINDEMANN, HANS WOLFGANG (J) engineer, Delling Motors Co., West Collingswood, N. J.; (mail) 569 Haddon Avenue, *Collingswood, N. J.*

MANWARING, H. S. (M) field sales manager, Zenith-Detroit Corporation, Foot of Hart Avenue, *Detroit.*

MARSH, JAMES WILLARD (A) instructor, Southern Branch, University of California, *Los Angeles;* (mail) 653 Tularosa Drive.

MAYNARD, JOSEPH S. (A) assistant general sales manager, Richardson Co., 250 West 57th Street, *New York City.*

MERIAM, WELLES (A) associate examiner, United States Patent Office, City of Washington; (mail) *Kensington, Md.*

MILLER, H. L. (A) shop foreman, Frosaker Blaisdell & Co., *Minot, N. D.;* (mail) 622 East Central Street.

MONSCHEUER, ERICH (A) director and general manager, Ambi-Werke, Berlin-Johannisthal, Germany; (mail) Wilhelmstrasse 23, *Berlin-Kaulsdorf, Germany.*

MOULD, JAMES A. (M) chief engineer, Evinrude Motor Co., *Milwaukee;* (mail) 397 Olive Street.

MURPHY, H. W. (A) service manager, Mack-International Motor Truck Corporation, 5133 Grand River Avenue, *Detroit.*

PEARSON, FRANK C. (M) designing engineer, Reo Motor Car Co., *Lansing, Mich.;* (mail) 1008 Clear Street.

PELAN, JOHN S. (A) in charge of electrical experimental labora-

tory, International Motor Co., Long Island City, N. Y.; (mail) 2558 Grand Concourse, *New York City.*

PHELAN, MATTHEW A. (A) branch manager, International Motor Co., *Hartford, Conn.;* (mail) 35 Eastview Street.

RAISCH, CHARLES F. (J) mechanical engineer, Cruban Machine & Steel Corporation, New York City; (mail) 842 South 16th Street, *Newark, N. J.*

RAWLE, JAMES W. (A) second vice-president, J. G. Brill Co., 62nd Street and Woodlawn Avenue, *Philadelphia.*

RAYBURN, A. G., experimental engineer, Emory Winship, San Francisco; (mail) 1324 Emerson Street, Northwest, *City of Washington.*

REED, HAROLD V. (M) engineer, Borg & Beck Co., 6558 South Menard Avenue, *Chicago.*

RICHARDS, C. R. (M) engineering division, automotive department, Vacuum Oil Co., 61 Broadway, *New York City.*

RIEHL, WILLIS A. (A) factory superintendent, Brooks Steam Motors, Ltd., *Stratford, Ont., Canada;* (mail) 144 Elizabeth Street.

RIKER, M. J. (A) service representative, Chrysler Sales Corporation, Detroit; (mail) Bellevue Hotel, *San Francisco.*

RISLEY, DALTON, JR. (A) general manager, Craveroiler Co. of America, 4523 Tacony Street, *Philadelphia.*

ROBERTSON, BURTON J. (M) assistant professor of gas engineering, University of Minnesota, *Minneapolis;* (mail) 18 Barton Avenue, Southeast.

ROTHERT, HARRY (A) production manager, Ahrens-Fox Fire Engine Co., Cincinnati; (mail) 3230 Stanhope Avenue, *Westwood, Cincinnati.*

RYAN, WALTER D'ARCY (M) director of illuminating engineering laboratory, General Electric Co., *Schenectady, N. Y.;* (mail) 1848 Union Street.

SCHORY, CARL F. (A) secretary of contest committee, National Aeronautic Association, 1623 H Street, Northwest, *City of Washington.*

SCHUNCK, FRED E. (J) garage storekeeper, Milwaukee Electric Railway & Light Co., Milwaukee; (mail) 4706 Beloit Road, *West Allis, Wis.*

SEDDON, WILLIAM (F M) chief draftsman, Morris Motors, Ltd., Cowley, Oxford, England; (mail) Bellavista, Sandfield Road, *Headington Hill, Oxford, England.*

SEDDON, WILLIAM R. (M) engineer and general manager, Seddon Motor Car Co., Wiess Avenue and Mill Road, *Flourtown, Pa.*

SHERRICK, EVERETT B. (J) draftsman, Cadillac Motor Car Co., *Detroit;* (mail) 6900 Lafayette Boulevard.

SHIPWAY, GEORGE E. (A) president, Salt's Textile Mfg. Co., Bridgeport, Conn.; (mail) *Noroton, Conn.*

SHUTTS, LEROY W. (J) layout draftsman, General Motors Corporation Research Laboratories, *Detroit;* (mail) 1616 Waverly Avenue.

SMITH, CLINTON D. (A) general manager, Beaver Valley Traction Co., P. O. Box 238, *New Brighton, Pa.*

SPRACKLING, GEORGE A. (J) service school instructor, Chevrolet Motor Co. of Wisconsin, *Janesville, Wis.;* (mail) 333 Forest Park Boulevard.

STEPHENS, JAMES H. (A) superintendent of railways, Washington Railway & Electric Co., 231 14th Street, Northwest, *City of Washington.*

STOUGHTON, EDWARD L. (A) vice-president and general sales manager, Wico Electric Co., *Springfield, Mass.*

STUCK, CHARLES (A) sales manager, E. S. Cowie Electric Co., 1818 McGee Street, *Kansas City, Mo.*

TILSTON, CHARLES E. (M) engineer, Willys-Overland, Ltd., *West Toronto, Ont., Canada.*

TRENT, HARRY C. (A) secretary in charge of service, Colt-Stewart Co., 631 West 57th Street, *New York City.*

TUCKER, RUFUS S. (A) sales agent, Bethlehem Steel Co., *Bethlehem, Pa.*

VALPEY, HENRY H. (A) quality supervisor and sales engineer, clutch division, Long Mfg. Co., Cameron Avenue and East Grand Boulevard, *Detroit.*

VAN SANT, JOHN E. (A) service manager, Paul G. Hoffman Co., *Los Angeles;* (mail) 1256 Figueroa Street.

VOLLES, ARTHUR J. (A) assistant engineer, Precision Castings Co., Inc., *Fayetteville, N. Y.;* (mail) 217 Thompson Street.

WHIGAM, ELGIN B. (A) engineer, Earl B. Staley Co., *Seattle;* (mail) 923 East John Street.

WILLOUGHBY, FRANCIS D. (A) president and general manager, Willoughby Co., Dwyer Avenue, *Utica, N. Y.*

WOOD, CLARK V., JR. (J) superintendent of motorcoach division, United Electric Railways Co., 100 Fountain Street, *Providence, R. I.*

WUNSCH, JOSEPH W. (A) president and chief engineer, Silent Hoist Co., 302 McDougal Street, *Brooklyn, N. Y.*

Applicants *for* Membership

The applications for membership received between Nov. 14 and Dec. 15, 1925, are given below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

BACON, ELBRIDGE F., assistant instrument engineer, engineering division, Air Service, McCook Field, *Dayton, Ohio.*

BARNETT, L. M., sales manager, General Motors Corporation, *Detroit.*

BARR, ROGER B., transportation director, Coral Gables Corporation, *Coral Gables, Fla.*

BOMAR, CAPT. ERNEST C., Ordnance Department, Watertown Arsenal, *Watertown, Mass.*

BORDEN, LAWRENCE L., president and general manager, Textile Trucking Co., *Fall River, Mass.*

BOURQUE, WILLIAM D., detailer, American Body Co., *Buffalo.*

BOYD, MERVYN J., service superintendent, Federal Motor Truck Co., *San Francisco.*

BRANNAMAN, WHEELER O., president, Oneonta Storage Battery Corporation, *Oneonta, N. Y.*

CASSON, WESLEY C., designer, Cadillac Motor Car Co., *Detroit.*

CLO, J. HARRY, research engineer, A. Schrader's Son, Inc., *Brooklyn, N. Y.*

CONSTANTINE, ARTHUR R., development engineer, Harley-Davidson Motor Co., *Milwaukee.*

CRARY, RALPH W., president, Nite-Eye Reflector Co., *Waukesha, Wis.*

CRAVEN, DAVID S., district service-manager, White Co., *San Francisco.*

CUGGIA, EDUARDO A., assistant service engineer, General Motors Argentina, *Buenos Aires, Argentine Republic, South America.*

CULBERTSON, E. ESTAY, personal and private developments, *New York City.*

DE HART, HENRY T., advertising manager, Reo Motor Car Co., *Lansing, Mich.*

DENISON, W. C., JR., general manager, Cook Motor Co., *Delaware, Ohio.*

EAGLES, NELSON W., chief engineer, motorcoach division, St. Louis Car Co., *St. Louis.*

ENGEL, ALBERT F., salesman, Bassick Mfg. Co., *Chicago.*

FISHER, LAWRENCE P., president, Cadillac Motor Car Co., *Detroit.*

FLANAGAN, JAMES GERALD, chassis design draftsman, Six Wheel Co., *Philadelphia.*

FLOCKER, ANTHONY MARIO, general manager, Lancia Motors Sales Corporation, *New York City.*

GIBSON, WILLIAM B., vice-president and general manager, William B. Gibson, Inc., *San Francisco.*

GODWARD, ERNEST ROBERT, chief engineer, Godward Vaporizer, Inc., *New York City.*

GOEHRING, EDWARD P., chassis draftsman, Six Wheel Co., *Philadelphia.*

GRANGER, B. D., manager, C. M. Hall Lamp Co., *Kenosha, Wis.*

GREVE, LOUIS WILLIAM, president, Champion Machine & Forging Co., *Cleveland.*

GRIFFITHS, CHARLES R., sales engineer, C. G. Spring & Bumper Co., *Cleveland.*

HALLOCK, GIFFORD HULL, airplane inspector, procurement section, Air Service, *New York City.*

HEMINGER, J., shop superintendent, Federal Motor Truck Co., *Oakland, Cal.*

HICKS, GEORGE, chassis draftsman, Six Wheel Co., *Philadelphia.*

HOPKINS, ALBERT L., storage-battery engineer, Prest-O-Lite, Inc., *Indianapolis.*

JACOBUS, F. LESLIE, junior engineer, Public Service Transportation Co., *Irvington, N. J.*

JOHNSON, RAYMOND P., assistant to supervisor of motor transportation, Standard Oil Co. of New York, *New York City.*

JOHNSTON, JAMES A., mechanical engineer, Commerce Motor Co., *Ypsilanti, Mich.*

JONES, EDWARD T., engineer, Wright Aeronautical Corporation, *Paterson, N. J.*

KAHN, ARTHUR J., designer of automotive equipment, Modern Vehicle Co., *San Francisco.*

KAISER, FRITZ, mechanical engineer, Mack plant, International Motor Co., *Allentown, Pa.*

KEARBY, E. J., president, Metal Products Co., St. Joseph, Mo.; vice-president and manager, St. Joseph Clutch Co., Inc., *St. Joseph, Mo.*

KING, CARLYLE J., secretary to chief engineer, American Body Co., *Buffalo.*

KINSMAN, JOHN K., assistant equipment engineer, California Highway Commission, *Sacramento, Cal.*

KLEINBAUM, ELIHU N., vice-president and general manager, M. P. Moller Motor Car Co., *Hagerstown, Md.*

KORSHIN, MATTHEW R., special representative, Whitney Mfg. Co., *Hartford, Conn.*

LARKIN, I. ENOS, service engineer, Philbrin Corporation, *Kennett Square, Pa.*

LEMMON, GUY, sales manager, Robert H. Hassler, Inc., *Indianapolis.*

LEWIS, H. G., vice-president, Electric Service Supplies Co., *Philadelphia.*

LOMAX, WALKER, assistant superintendent of equipment, People's Motor Bus Co., *St. Louis.*

MCDONELL, HORACE G., maintenance representative, Uppercu-Cadillac Corporation, *New York City.*

MCKIERNAN, SAMUEL L., engineer, Yale & Towne Mfg. Co., *Stamford, Conn.*

MARTELL, CHARLES S., production manager, Apco Mfg. Co., *Providence, R. I.*

MATHEWS, EUGENE H., sales engineer, Prest-O-Lite, Inc., *Indianapolis.*

MERZ, CHARLES C., assistant to president, H. C. S. Cab Mfg. Co., *Indianapolis.*

MILLS, J. E., manager of technical service, Packard Motor Car Co., *Detroit.*

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